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A FLEET OF STEEL CANAL BOATS of the Cleveland Steel Canalboat Co., arrived in New York May 13. It consisted of one steam barge with five consorts, all loaded to a draft of 5 ft., which is the maximum now practicable in the Erie Canal. The fleet left Cleveland May 3 at 1 a. m., arrived at Buffalo May 4 at 8 a. m., left Buffalo May 4 at 6 p. m., arrived at New York May 13 at 8 a. m.; lost 10 hours at Buffalo on account of ice in the harbor, 4 hours at Brockport cleaning fires, 4 hours at Troy waiting for teams through single locks; total, 18 hours lost time. Actual running time from Cleveland to New York, 9 days, 13 hours; Cleveland to Buffalo, 31 hours; Buffalo to Troy, 5 days, 20 hours; Buffalo to New York, 7 days, 12 hours. The cargo included 653,000 lbs. of nails for export to Japan; 375,000 ft. of lumber for New York; 10 tons parafine wax for Germany, and a miscellaneous cargo for New York. The westbound cargo will consist chiefly of sugar for Detroit, Toledo, Cleveland and the southwest.

THE CANAL IMPROVEMENT movement in England has been making great advances within the past few years, and several of the old abandoned and almost abandoned canals have been improved and reopened under new and vigorous management. The latest canal to be thus taken in hand is the Thames & Severn Canal, 28¾ miles long, extending across the country from Inglesham, on the Thames, to Wallbridge, where it connects with the Stroud Canal, extending 8 miles farther to the River Severn. There are 44 locks, the canal rising 130 ft. 6 ins. from Inglesham to the summit, and falling 241 ft. to Wallbridge. The locks are 13×93 ft. to 16×68 ft. The Sapperton tunnel is 11,424 ft. long, 11 ft. 6 ins. wide at water line, and with a headway of 12 ft. above the water. The canal has 5 ft. 6 ins. depth of water. It was first opened in 1779, and had a good financial history until 1841, since which time the business has declined, and the canal has been practically abandoned for several years. A considerable amount of work is now required to clean it out, put it in repair and deepen the channel of the Thames for some miles to render it navigable for the canal boats.

A FAST TRANSATLANTIC RUN has been made by the steamer "St. Paul," of the American Line. It left Southampton at noon on May 9, and made the run of 3,112 miles in 6 days, 9 h., 5 mins., or at the average rate of 20.34 miles per hour. The "New York," of the same line, had formerly made a record over the shorter summer run of 3,047 miles in 6 days, 7 h., 14 mins., or at the average rate of 20.15 miles per hour; while the "Fuerst Bismarck," of the Hamburg-American Line, had a record of 6 days, 10 h., 32 mins. The daily runs of the "St. Paul" were 481, 514, 480, 493, 509, 522 and 111 knots.

THE STEEL ARCH BRIDGE AT NIAGARA FALLS, which is to replace the old suspension bridge, is to be built by the Pennsylvania Steel Co., of Steelton, Pa. The contract was awarded May 16, and amounts to about $500,000. The bridge was described in our issue of March 5.

A NEW BRIDGE AT ST. LOUIS, MO., over the Mississippi River has been authorized by a bill recently passed by House and Senate. The bridge is to be at least ¾ mile from either of the existing bridges.

ONLY ONE BIDDER FOR A NEW WATER SUPPLY for Jersey City appeared on May 18, when bids were opened for furnishing 35,000,000 gallons of water per day for 25 years, with an increase to 50,000,000 gallons or purchase of works of either capacity, at the option of the city. The Rockaway & Hudson Water Co. offered to deliver water to the Jersey City high-service reservoir, 210 ft. above tide, under two different plans. One of these was similar to its own plan, presented about a year ago, and the other is said to be almost identical with that proposed by the Jersey City Water Co. at the same time, and for which an award was made by the city authorities and upset by the court. Under the first-named plan the company offers to take water from the Rockaway River at Boonton, at which, and other points, storage reservoirs would be built. The other plan is for a supply from the headwaters of the river, with a smaller drainage area, larger number of storage reservoirs, and a point of intake further removed from Jersey City. The prices, per 1,000,000 gallons, at which water is offered under the two plans and the purchase option prices, are as follows:

	Hdwrs. of Rockaway River.	Rockaway River.
First 20,000,000 gallons	$36.00	$38.00
20,000,000 to 30,000,000 gallons.....	33.00	37.00
30,000,000 to 40,000,000 gallons.....	30.00	36.00
40,000,000 to 50,000,000 gallons.....	27.00	34.00
Purchase option, 35,000,000-gal. plant.	6,250,000	6,500,000
Purchase option, 50,000,000-gal. plant.	6,950,000	7,500,000

The above bid for a 50,000,000-gallon plant taking water from the Rockaway River, is said to be about $1,000,000 higher than the bid of the same company on a supply from the same source last year, while its bid for the upper Rockaway plant, is said to be about $500,000 less than the bid of the Jersey City Water Co. last year. What difference there may be in the detailed plans for the last year and this, is not pointed out.

The Jersey City Water Co. sent in a short letter stating that the time allowed for building the works, two years, was too short, so that it could not bid, and the East Jersey Water Co., which has put in a bid on four previous occasions, sent in a long letter urging that no intelligent bids were possible under the specifications. No bids were received under the filtration specifications, as we have predicted would be the case, while the bids for a gravity supply showed no competition even among the companies which have been figuring for months or years on supplying Jersey City.

A MILLION DOLLARS FOR NEW WATER MAINS in New York city is authorized by a legislative statute just signed by Governor Morton. It is said that the bill provides for two mains down Fifth Ave. At present eight 48-in. mains lead down into the city from the new aqueduct, four going to the Central Park reservoir and four connecting with the distributing mains.

BIDS FOR LAYING A 6-FT. STEEL SUBMERGED conduit at Toronto, Ont., are wanted until June 3, as stated in our advertising columns. The conduit will be 2,358 ft. long, and will replace a wooden pipe extending from Toronto Island to the bell-buoy crib in Lake Ontario. Mr. Bernard Saunders is Chairman of the Committee on Works, and Mr. E. H. Keating, M. Am. Soc. C. E., is City Engineer.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a fast freight train by train wreckers at Waldo, Wis., May 15, on the Chicago, Milwaukee & St. Paul Ry. A pile of ties placed on the rails threw nearly the entire train off the track, three men being killed and two injured.——A head collision of freight trains occurred May 19 on the Columbia, Newberry & Laurens R. R., near Chapin, S. C., owing to a mistake in the train orders. Three men were killed and 14 cars were burned in the wreck.

THE COALING TRESTLE for loading lake vessels at Charlotte, N. Y., was partly wrecked by runaway cars May 18. A cut of cars had been sent down to the chutes, and the brakes not being properly set on the next cut of cars, this also ran down, causing a collision on the trestle. About 300 ft. of the trestle and chutes collapsed, but nobody was hurt. The trestle is 1,000 ft. long, and the damage to the trestle, chutes, cars and vessels will amount to about $18,000.

A CANAL BRIDGE at Fort Plains, N Y., gave way May 17, while a stage and a drove of cows were crossing. The passengers climbed out of the windows of the stage and were rescued. The structure is said to have been rotten and unsafe.

A NAPHTHA EXPLOSION occurred in the works of the Central Gaslight Co., at 138th St., New York city, May 15, by which six men were badly burned. One of the men had carelessly opened a tap on a pipe through which naphtha was being forced, and the gas was exploded by a furnace near by.

AN EXPLOSION OF AFTER-DAMP in the Mongah mine, near Pittsburg, occurred May 14, by which one man was killed. The accident is attributed to the failure of the fire boss to make proper inspection. He claimed to have inspected the room that morning, but admitted he had not marked the date of inspection as required by law.

A CYCLONE IN TEXAS on May 15 almost wrecked the city of Sherman, in which over 100 persons were killed, while other places were also seriously damaged, and many persons killed and injured.

A SHELL CHARGED WITH HIGH EXPLOSIVE burst in the breech chamber of a 6-in. gun at the Indian Head proving grounds on May 15. The gun itself did not burst, but chamber and bore were ruined. It is expected that the gun can be bored out for a lining tube and used again for experimental work.

A NEW FAST TRAIN SERVICE between New York and Buffalo, over the Lehigh Valley R. R., was started May 17. The trains will make the run of 448.6 miles in 10 hours, leaving each end of the line at noon. On the first trip the northbound train made the run in 9 hours 46 minutes, or 9 hours 8 mins. running time. Each train consists of a combination baggage, dining and smoking car, 77 ft. long (with library, writing desks, etc.), two Pullman day cars, and an observation parlor car, with a women's sitting room and seating capacity for 28 persons.

A FREIGHT VIADUCT in New York city, with spur tracks to the piers on the North River, is proposed by the New York & New Jersey Bridge Co. The viaduct would be a double deck plate girder structure, extending from 55th St., down 12th Ave., 13th Ave and West St. to the Battery.

LIGHT RAILS FOR JAPAN are being manufactured at the Bay View mills of the Illinois Steel Co., near Milwaukee, Wis., and will be sent to New York to be shipped by steamer to Japan. The order comes through the China & Japanese Trading Co. The contract price is said to be $21.36 per ton.

A STREET CAR WITH PIVOTED SEATS is being tried on the Grand St. and Desbrosses St. line in New York city. There are ten chairs on each side, facing towards the front of the car, the seats being supported on brackets. This enables seated passengers to avoid having their feet stepped on by those who are standing on or walking through the car. The seats are reversed at each end of the route by means of a lever. The car was built at the shops of the Dry Dock & East Broadway Ry. Co.

THE CONTRACTS FOR ARMOR PLATE for the new battleships "Kearsarge" and "Kentucky" have been awarded to the Carnegie Steel Co. and the Bethlehem Iron Works at $522.07 per ton. The former company will supply 3,007 tons for $1,660,518; and the latter, 2,653 tons for 1,464,192.

A TEST OF ARMOR PLATE made by the Bethlehem Iron Co. for the Russian government took place at the Indian Head proving grounds on May 13. Nine shots were fired at an 8-in. Harveyized plate, six 6-in. and three 4-in. Holtzer shells being used. All the shells were smashed on the plate after penetrating a few inches, the plate being practically uninjured. The plate tested represented 600 tons of armor, which was accepted by Capt. Mortwago, the military and naval expert attached to the Russian legation at Washington.

A TELEGRAM was sent almost around the world from the electrical exposition building in New York city on the evening of May 16. At 8.34 o'clock p. m., Hon. Chauncey Depew sent the following message from one end of the gallery to Mr. Edward D. Adams, president of the Niagara Power Co., at the other: "God creates, nature treasures, science utilizes electric power for the grandeur of nations and the peace of the world." The message traveled over the Postal Telegraph wires via Chicago, Los Angeles and San Francisco to Vancouver, B. C.; from here to Winnipeg, Montreal, Canso, London, Lisbon, Gibraltar, Malta, Alexandria, Suez, Bombay, Madras, Singapore, Shanghai, Nagasaki to Tokio. From Tokio the message returned by the same route and was received by Mr. Adams in the west gallery at 9:24 p. m., having traveled 27,500 miles in 50 minutes. An interesting incident of the feat was that Mr. Thos. A. Edison was the operator at the receiving instrument.

THE BATTLESHIP "OREGON," in her trial trip off Santa Barbara, Cal., on May 14, made a speed of 16.78 knots.

THE JEWELL MECHANICAL WATER FILTER PLANT AT WILKES BARRE, PA.

(With inset.)

In our issue of Jan. 4, 1895, we described at length the Warren system of mechanical filtration. Since that date we have published descriptions of several sand filter bed plants and have been collecting information regarding the Jewell mechanical filter.

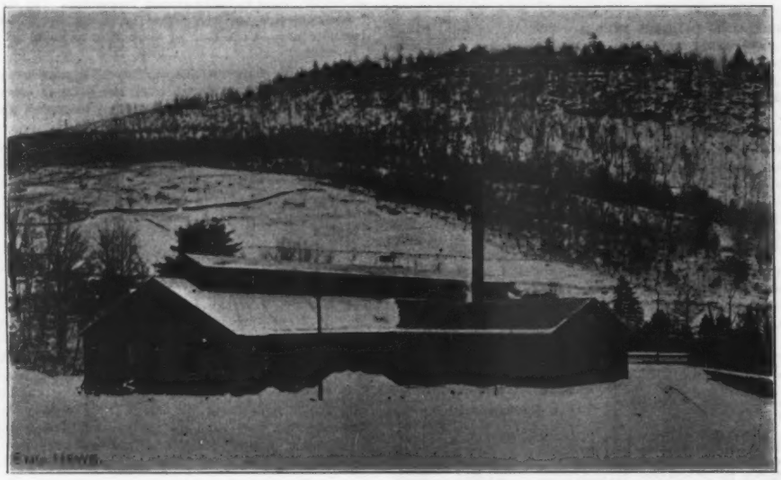


FIG. 5.—VIEW OF FILTER HOUSE AT WILKES BARRE.

General Description of the Jewell System of Filtration.

The Jewell filter was invented by Mr. Omar H. Jewell. The first filters of this type are said to have been built in the seventies, but no patents were taken out until 1887. Since then patents have been taken out at various intervals, and the apparatus is now covered by about 80 patents.

The filter is sold by the O. H. Jewell Filter Co., of Chicago; the Morison-Jewell Filter Co., of New York and Philadelphia, and the Pacific Jewell Filter Co., of San Francisco.

Some of the distinctive features and advantages claimed for this system of filtration are given by Mr. S. L. Morison, Vice-President and Manager of the Morison-Jewell Filtration Co., as follows:

Filters of both the gravity and pressure type are made under the Jewell patents, but most of those in use are gravity filters. In the latter allowance is made for 10 ft. of friction head in the sand bed. It is claimed that this allows the use of finer sand and permits less frequent washings than would be possible with a smaller head. For a rate of filtration of 128,000,000 gallons per acre per day the friction head would be 2.44 ft., with the filtering material clean, according to Mr. E. B. Weston's results in the Providence Experiments (see Engineering News, April 16, 1896).

Some of the more recently constructed filters have a double tank, as shown by Fig. 3, on the inset sheet. The inner tank here shown has an inside diameter of 12 ft., and extends only 9 ins. above the top of the filter bed. Between the inner and outer tank is a narrow annular space, down which the wash water falls. This allows a free and full delivery of the wash water, holding the entire bed loose and permitting the foreign matter retained by the filter to float off readily.

The screen system in the bottom of the filter, also shown by Fig. 3, is designed to permit of the most thorough washing under high pressure. The screens are tested to 100 lbs., and sometimes work under 40 lbs. pressure. In each filter of the full standard size (13⅜ ft. outside diameter, 12 ft. diameter and 113 sq. ft. area of filter bed), there are 446 screens. The screens are of aluminum-bronze, copper riveted between two gun metal flanges.

All of the Jewell plants are steam connected, the steam being used to cleanse and sterilize the filters. In 1893, Mr. John Farnsworth, Treasurer of the Providence Dyeing, Bleaching & Calendering Co., tried soda ash for cleansing the filtering material at intervals. The process is now recommended for use in connection with city plants of the Jewell type.

Machine crushed quartz is always used in the filters put in by the Morison Co., and generally in all the other plants, but in one or two Western plants natural sand is used. The quartz comes from northern New Hampshire and the Berkshire Hills, in Massachusetts. It is screened before being used and has an effective size of (10% of the grains by weight having a diameter less than) 0.38 mm. (0.0142 ins.).

The discharge pipe for filtered water is brought from beneath the beds to a point 18 ins. above their surface, an air pipe being provided at the uppermost part of the bend to prevent siphoning. This practice is designed to prevent suction through the bed.

Some of the main points covered by the patents are: The screen system; deflector plates for spreading the water over the beds, as described below, under the Wilkes Barre plant; the reversible agitator for stirring the sand while it is being washed; the inner and outer tanks; and the combination of a settling basin with a filter tank, the latter being placed below the filter bed and being in use at Belleville, Ill., and at Cedar Rapids and Ottumwa, Ia.

The tanks for gravity filters are generally made of cypress. A tank 12 ft. in diameter (of filter bed) would have a daily capacity of 340,000 gallons on a bad water. The tank proper weighs 6,500 lbs., the machine work 4,800 lbs., and the filtering material 30,000 lbs. The largest standard size of pressure filter (steel) is 8 ft. in diameter and 8½ ft. high, has a rated capacity of 150,000 gallons a day on bad waters, weighs 8,600 lbs., and contains 10,000 lbs. of filtering material.

The Two Plants at Wilkes Barre, Pa.

The recent consolidation of the two water companies at Wilkes Barre, Pa., brings under one management two mechanical filter plants having a combined daily capacity of 14,000,000 gallons. One of the plants is not now in operation, it is said, for reasons which are given below. Aside from their size, these Wilkes Barre filter plants are unique and interesting in other particulars. They are both gravity filter plants, located on gravity supplies, and for neither is extra pumping required on account of filtration. In one case the water to be filtered is sometimes deficient in carbonate of lime, and in the other has barely enough, this substance being essential where alumina is used for a coagulant. Each of the original water companies was ordered to adopt some method of purification by the City Council, as set forth in detail further on.

The Plant of the Wilkes Barre Water Co.

The works of the Wilkes Barre Water Co. were built in 1857-9. The company draws a gravity supply from impounding reservoirs, the combined storage capacity of which is over 2,000,000,000 gallons. Prior to the completion of a large new reservoir the gravity supply was supplemented by pumping from the Susquehanna River. The new reservoir has a storage capacity of about 2,000,000,000 gallons and was put in use in August, 1891. The reservoir covers nearly 400 acres and has an average depth of 15⅓ ft. Its drainage area is eight square miles. It is about three miles above the filter plant, to reach which the water flows down the channel of a natural stream, falling nearly 300 ft.

FIG. 6.—COAGULANT TANKS AT WILKES BARRE.

The first summer the reservoir was in use trouble was caused by algae growths, beginning in July and reaching its height in September, the algae forming a green scum on the surface

of the reservoir and even showing in the city. The water was described as having a fishy odor and taste.

From an account published in the Wilkes Barre "News Dealer" for July 29, 1892, it would appear that some of the trouble arose from organic matter left in the bottom of the reservoir when it was constructed, including vegetable growths and "black mud, so-called by the farmers, into which a pole can be thrust to a depth of from 5 to 15 ft."

The Old Sand Filter Bed of the Wilkes Barre Water Co.—In the summer of 1893 the company built 12,000 sq. ft. of filter bed above the intake dam and present filter house. A dam extends across the stream at this point, whether put in or not at the time the filter bed was constructed we cannot say. At this dam the water was 8 to 9 ft. deep over the filter bed. The filtering material was placed on 2-in. plank, resting on supports 18 ins., c. to c., which raised the plank 2 ft. above the ground. At the bottom of the filter bed was 10 ins. of 2-in broken stone, then came 6 ins. of ordinary river gravel, and finally 4 ins. of sea sand from Long Island, supplied by a local contractor. This made the filter bed only 20 ins. deep.

All the filtered water finally passed through coke and animal charcoal, confined in a chamber 6 ft. 1 in. sq. The coke was 3 ft. deep, put in loose. The animal charcoal was 1½ ft. deep, and was placed in two trays on top of the coke, the trays being bolted down. The coke and charcoal were taken out at intervals varying from one to three months. Sometimes it was washed and put back and sometimes it was in too bad a condition for further use. The coke got into a worse condition than the charcoal, in just what respect we are not informed.

The filter bed was sometimes cleaned two or three times in a month and sometimes in winter it went two or three months without cleaning. About 25 men, working two days, were required to clean the bed. From 2 to 3 ins. of sand were removed at times and again the only attempt was to scrape off the matter accumulated on the surface of the bed. The actual amount of sand required for renewals is given as perhaps about 3 ins. per year. While the bed was being scraped the water was passed around it without filtration.

As might have been expected from a bed of such small area and thickness, the results from this sort of filtration were not all that could be desired. Some grosser matters were strained out, but it appears that the water was still turbid and colored at times and presumably the bad taste and odor continued during the summer. The filter bed was kept in use until the new filter plant was started, but the rate of filtration is not stated. From the scanty information at hand it seems fair to assume that at least 5,000,000 gallons a day passed the 12,000 sq. ft. of filtering area, which would be at the rate of 417 gallons per sq. ft., or about 18,000,000 gallons per acre per day, which is many times the proper rate for sand filtration.

A City Ordinance for Compulsory Filtration.—The Wilkes Barre Water-Works Co. was not alone in furnishing unsatisfactory water. In June, 1894, a special committee recommended the passage of an ordinance making filtration compulsory on the part of all companies supplying water within the city. The ordinance contained other provisions relating to the purity of water supplies, in accordance with suggestions made by a local medical society. Through the kindness of Mr. Frank Deitrick, City Clerk, we are enabled to present a copy of the ordinance as passed on July 10, and approved by Mr. F. M. Nichols, Mayor, on July 19, 1894. The general action of the Wilkes Barre City Council in this matter might be followed with profit by some other cities of the United States and Canada, provided they are possessed with the necessary legal power. The body of the ordinance, with slight typographical changes to conform to our standards, is as follows:

Sec. 1. Any person, companies or corporations willfully or negligently furnishing to the people of this city water for domestic purposes in a state of impurity or impregnated with the germs of disease or any other matters deleterious to health, upon conviction thereof, shall be required to pay for the first offense a penalty of not more than $100, and for every subsequent offense a penalty of not more than $200.

Sec. 2. It shall be the duty of all persons, companies and corporations furnishing to the people of this city water for domestic purposes through pipes located in the public streets to adopt, use and maintain in the most efficient condition and without unnecessary interruption for the purification of said water, some system of filtration now employed in the cities of the United States or Europe which experience has shown to be most effective in freeing water from impurities, deleterious organic matters and germs of disease and rendering the same clean and wholesome.

Provided, however, that the adoption of the system of filtration through sand beds, such as are used in London and Berlin, shall not be deemed a compliance with this ordinance, unless the said sand beds are at least 5 ft. deep, and in working the same not more than 40 gallons of water per sq. ft. of area are allowed to pass through said sand beds per 24 hours.

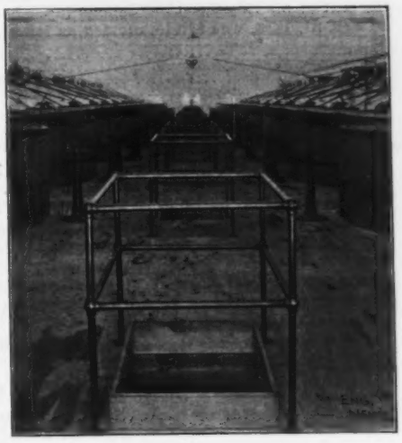


Fig. 7.—Upper Floor of Filter House at Wilkes Barre, from Settling Tank End.

Fig. 8.—Clear Water Flume and Wash Water Main at Wilkes Barre, Looking Between the two Rows of Filter Tanks.

Sec. 3. It shall also be the duty of such persons, companies or corporations to adopt and use, without unnecessary interruption and in the most efficient manner, such measures as may be necessary to prevent contamination of the water at its source and at all places where it shall flow or be collected before reaching the places where it is filtered, in obedience to the requirements of the second section of this ordinance.

Sec. 4. Any persons, companies or corporations violating either section two or section three of this ordinance, shall pay a penalty of $100 for each and every day such violation shall be continued.

Sec. 5. For the purpose of aiding the enforcement of this ordinance the office of water inspector is hereby created; the incumbent thereof shall be an expert chemist and bacteriologist, to be appointed and his compensation to be fixed annually by an ordinance of City Council and it shall be the duty of the water inspector to make bi-weekly chemical and bacteriological analyses of the water supplied to the people of this city for domestic purposes and immediately report the results of the same to the Sanitary Committee and to all persons, companies and corporations furnishing the said water and also from time to time inspect the system or systems of filtrations adopted in obedience to this ordinance and whenever the same are not kept and operated as herein specified, make report thereof to the parties aforesaid.

Sec. 6. This ordinance shall go into effect on Nov. 1, 1894, and a certified copy thereof shall forthwith, upon its passage, be served upon the persons, and officers of the companies and corporations aforesaid, in order that ample opportunity may be offered before that time to prepare for compliance with its provisions.

Sec. 7. All ordinances or parts of ordinances inconsistent herewith be and the same are hereby repealed.

The 10,000,000-Gallon Jewell Filter Plant.—After operating an experimental plant the Wilkes Barre Water Co. contracted with the Morison-Jewell Filtration Co. for gravity mechanical filters with a guaranteed daily capacity of 10,000,000 gallons. The plant was tested the latter part of July, being run at the rate of 11,100,000 gallons per day, and was put in operation on Aug. 1, 1895. It ran intermittently, while adjusting its various parts, until Sept. 15, when it was shut down until Dec. 31, since which it has been in continuous operation. Most of the information regarding this plant was obtained during a visit to the plant on March 2, 1895, by a member of the staff of this journal, from Mr. Roger McGarry, who, for 25 years has been Superintendent of the Wilkes Barre Water Co. The photographs and blue prints from which the illustrations have been prepared were furnished by Mr. S. L. Morison, Vice-President and Manager of the Morison-Jewell Filtration Co., Havemeyer Building, New York. Mr. Edmund B. Weston, M. Am. Soc. C. E., of Providence, R. I., was Consulting Engineer to the company and prepared all the general plans for the plant.

The water comes by gravity to the filter house from either one or both of two small pools a few feet distant, these now serving as settling basins, although having been built for other purposes. The water is screened as it leaves the pools and flows to the filter house through a 30-in pipe.

Fig. 1, on the inset sheet, is a plan of the filter house, showing the settling and filter tanks, their connections, and the boiler and engine room. Elevations and sections of the tanks are shown by Fig. 2, and the details of a typical Jewell filter tank by Fig. 3. The water deflector used to spread the water as it enters the filter tanks is shown by Fig. 4. All the figures named are on the inset sheet. Figs. 5 to 8, in the text, are reproduced from photographs. Fig. 5 is a general view of the filter house; Fig. 6 shows the coagulating tanks, the upper tank being used to supply the boilers at times. Figs. 7 and 8 are views of the filter tanks from above and below, Fig. 7 showing the mechanism for turning the revolving rakes and the valve stands for opening and closing the various feed and waste pipes, while Fig. 8 shows the clear water flume and some of the lower pipe connections.

The filter house is of brick, the main building being $51\frac{2}{3} \times 181\frac{2}{3}$ ft., over all, and the engine and boiler room $34 \times 51\frac{2}{3}$ ft., over all. The filter tanks are supported on brick foundations, beneath which is a 2-ft. concrete floor which extends over the whole of the basement. All inside brick walls and the roof trusses are whitewashed; the roof ceiling, clear water flume and feed pipe for wash water shown in Fig. 8, are painted white.

The arrangement and detailed dimensions of the various parts of the plant can be seen by referring to the inset sheet. The unfiltered water comes first to the settling tanks, two on each side, where it receives the basic sulphate of alumina used as a coagulant. It then passes on through a 24-in. supply main on the outer side of each row of tanks, with branch connections to the several filters, the water entering above the filtering material and being spread by the deflectors, shown in detail by Fig. 4. The deflectors are designed to aerate the water and at the same time prevent the plowing up or packing of the sand by the water when it strikes the beds. They are attached to the vertical agitator shaft.

The filter tanks are made of cypress, the staves here

being 18 ft. long, an extra 4 ft. having been added to the height of the tank on account of local conditions. Each tank has a filtering area of 113 sq. ft., giving 2,260 sq. ft. for the 20 filter tanks, four valves are used to control the flow of water to and from the tanks. These are all operated from the upper floor and are placed side by side and labeled in the following order from left to right: "Sewer," "Rewash," "Wash," "Filtered." Each filter tank is numbered and has an electric push button by means of which, and the proper connections, signals are transmitted to the engine room for starting and stopping the machinery used in washing. The plan, Fig. 1, on the inset, should show 20 instead of 16 filter tanks, the four indicated by dotted lines having been put in under a supplementary contract after the drawings were completed.

Basic sulphate of alumina, with about 17% of alumina, is used as a coagulant. It is bought from the Pennsylvania Salt Co., of Philadelphia, in carload lots. It is delivered f. o. b.. at Trucksville, about 500 ft. from the filter house, at 1.75 cts. per lb. The company hauls the alumina to the filter house at a cost of about 50 cts. per ton, or 1-40 ct. per lb. The alum is prepared in the two lower tanks shown in the view, Fig. 6.

The maximum amount of alum used is given as ¾ grains per gallon. At times none is used, it being unnecessary, for instance, when the ground is frozen. The alum is mixed in two tanks 8 ft. in diameter and 10 ft. high, shown in Fig. 6. One tank is drawn upon while the alum is being mixed in another. The alum is placed on a rack at the top of the tank, and as the water takes up the alum the greater specific gravity of the latter causes it to fall to the bottom. To keep the solution all of the same specific gravity after mixing, compressed air is used to stir it up. The alum is pumped to the settling tanks by phosphor bronze pumps. The gate on the supply main keeps the influent at a fixed volume, and the amount of alum is varied by altering the speed of the pump.

Washing is done with filtered water and once in 24 hours, ordinarily, no matter how clear the water may be. The wash water is turned on to loosen the sand before starting the agitator, or revolving rake. The agitator revolves 8 to 10 times per min., and was run for six minutes on a tank which the writer saw washed. The wash water could be seen bubbling up through the sand bed when it was first turned on. In the latter part of February, 1896, an extraordinary flood occurred making the water so turbid that it was necessary to keep the washing going on continuously in some filters, while others were in operation. In 8½ hours 63 tanks were washed and notwithstanding this nine tanks became blocked. This was the worst water ever had at Wilkes Barre, it is said. The turbidity of the water in times of flood is in part due to the fact that before reaching the filters the water flows about three miles in the bed of a stream with 300 ft. fall. High hills rise at each side of the stream and a country road passes alongside it, the wash into the stream being great.

About 3,000,000 gallons of water a day were being drawn, on March 2, from the old Laurens run-supply, without filtration. This was being mixed with the filtered water, which since Dec. 31, 1895, had been produced at the rate of about 7,000,000 gallons a day.

The equipment of the boiler and engine room is as follows: There are two 50 HP. boilers, made by the Vulcan Iron Works, of Wilkes Barre. The boilers are equipped with automatic damper regulators. Both boilers were in use at the time of the writer's visit in March, but it was hoped that one would be sufficient when steam for heating was no longer necessary. A 10×10×12-in. Blake pump, with a capacity of 4.08 gallons per stroke, is used to lift filtered water for washing. The pump does fair work at 110 to 120 strokes per min., and the attendants are instructed to keep it up to 100 strokes. On the average the pump is operated at 110 strokes per min, for from 7 to 10 mins. to wash one filter, giving from 3,100 to 4,500 gallons per wash per tank. The water for washing is raised about 13 ft. A 15 HP. Taylor engine is used to drive the sand agitators, and there is a 6×10×12-in. Blake air compressor for agitating the solution in the coagulant tank.

The building is lighted by 64 incandescent 24-c. p. lamps, and the grounds by four arc lamps installed by Hessel & Lewis, of Wilkes Barre. The dynamo was made by the General Electric Co., and is driven by a Payne automatic engine.

On March 2, 1896, the force employed at the filter plant was reported by Mr. McGarry as one engineer, one fireman and one washer, in two shifts of twelve hours, making six men in all. One of the men rated as a fireman regulated the gates at the impounding reservoir, three miles distant, and changed the screens at the gate house of the pools at the filter house. On one day in February, 1896, the screens had to be changed once an hour for 15 hours on account of the wash from the adjacent country. On the same date Mr. McGarry informed the writer that the cost of filtering 7,000,000 gallons in 24 hours, on Feb. 21, 1896, was $16.15, divided as follows:

Two engineers at $2.15	$4.30
Two firemen at $1.75	3.50
Two laborers at $1.50	3.00
Coal	....
Hauling coal	.75
250 lbs. alum at 1¾ cts.	3.82
Total	$16.15

The amount filtered could be increased to 10,000,000 gallons without any additional labor.

Below is a letter, dated April 29, 1896, from Mr. McGarry, to Mr. John C. Trautwine, Assoc. Am. Soc. C. E., Chief of the Philadelphia Bureau of Water, in which figures are given for the cost of filtration under different circumstances, and some other information regarding the plant is furnished:

In reply to your inquiry regarding cost of filter plant will say that the total cost of constructing the same has amounted to $122,361.79.

At present we are filtering a little over 9,000,000 gallons daily, at an expense as follows:

Two engineers, at $2.15 per diem	$4.30
Two washers, at $1.62½ per diem	3.25
Fuel	1.30
Oil waste, etc.	.11
	$8.96

Regarding the results of filtration, will state that it is very satisfactory. The use of coagulant is only intermittant with us, using it only when the water is very turbid, and when it holds in suspension heavy deposits of loam which is carried into the creek. We have not used any chemical since April 7—nothing but quarts filtration, and the quality of the water is highly improved. A slight stain remains on our supply (without the use of any solution) which an expert might detect. I may add that we have had a run of 91 days and during this continuous run we used on an average of ⅛ grain sulphate of alumina per gallon.

The contract with the Morison-Jewell Filtration Co. covered the filtering plant proper, including all piping within the building and some machinery. The water company provided the building and foundations, the piping for steam-heating and the boiler and electric lighting plant, together with the upper tank shown in Fig. 6. This tank feeds the boilers after they have been emptied for cleaning and supplies a water closet in the engine room. The figure for cost given in the letter above includes the cost of the building, a waste channel past the clear water reservoir, and in fact all the expense borne by the company in installing a filter plant.

The Plant of the Crystal Springs Water Co., at Wilkes Barre.

Early in 1895 the Crystal Springs Water Co., another company operating in Wilkes Barre, contracted for a 4,000,000 gravity filter plant, which was put in operation on Aug. 1. This company, at the time of adopting filtration, was drawing its supply from two small streams and an impounding reservoir at one time called Stink Pond, but afterwards called Crystal Lake. Only the water from the latter source was to be filtered. A water famine developing shortly after the filter plant was put in use, the supply from the lake was nearly exhausted, exposing a large amount of vegetable matter which gave rise to much offense. This source of supply was condemned by the State Board of Health in October, and the supply from Solomon's Creek was shown to be badly polluted by sewage matter. We are informed that the water is now supplied from Pine Brook, only, and that the filter plant has not been in operation since last fall. From the report of the Inspector of the State Board of Health, and from other information, it appears that the so-called lake was originally a small, swampy pond, and that the exposure of organic matter at low water gave it the name of Stink Pond. A dam at the outlet of the pond, it appears, flooded an additional area of low land.

The filter plant here is in general similar to that one used by the Wilkes Barre Water Co. and described above. As it is not in operation no further description will be given. It was put in for the "removal of turbidity and organic stain."

The total number of city water-works in the United States in connection with which Jewell filters are in use is now 21. In our next issue we shall give, briefly, the experience which has been had with each of these plants, from information furnished us by the officers of the water-works using them.

HOW METER RECORDS ARE KEPT AT BATTLE CREEK, MICH.

The lives of most mortals are made up of a succession of more or less routine duties, requiring careful attention to small details if friction is to be avoided and work is to be performed with expedition. Water-works superintendents and secretaries are no exception to this rule. Their duties are multitudinous, often requiring a vast amount of routine clerical work, and are not infrequently accompanied with petty vexations. The meter department is especially liable to annoyances, and its records involve much labor. Anything which simplifies the work of this department and lessens the trials and tribulations of those who conduct it is eagerly welcomed by all concerned.

There are many different ways of keeping meter records, and there is room for much difference of opinion as to which way is best.

The particular way in which meter records are kept at Battle Creek, Mich., and some of the merits of the plan as they appear to Mr. W. W. Bridgen, Engineer and Superintendent of the water-works, are set forth in a letter which we have received from Mr. Bridgen, as follows:

You will find enclosed our meter table which we have used for several years and think the best one we have seen. The man who reads meters puts the reading down

METER TABLE.—7½ Gals. per Cubic Ft.

No. thousands Gallons.	No. of Cubic Feet.	No. thousands Gallons.	No. of Cubic Feet.	No. thousands Gallons.	No. of Cubic Feet.	No. thousands Gallons.	No. of Cubic Feet.
1	133	45	6000	165	22000	435	58000
2	267	48	6400	174	23200	450	60000
3	400	51	6800	180	24000	465	62000
4	533	54	7200	189	25200	480	64000
5	667	57	7600	195	26000	495	66000
6	800	60	8000	200	26667	500	66667
7	933	63	8400	210	28000	510	68000
8	1067	66	8800	219	29200	525	70000
9	1200	69	9200	225	30000	540	72000
10	1333	72	9600	234	31200	555	74000
11	1467	75	10000	240	32000	570	76000
12	1600	78	10400	249	33200	585	78000
13	1733	81	10800	255	34000	600	80000
14	1867	84	11200	264	35200	705	94000
15	2000	87	11600	270	36000	801	106800
16	2133	90	12000	279	37200	900	120000
17	2267	93	12400	285	38000	990	132000
18	2400	96	12800	294	39200	1000	133333
19	2533	99	13200	300	40000	1050	140000
20	2667	100	13333	315	42000	1140	152000
21	2800	105	14000	330	44000	1200	160000
24	3200	114	15200	345	46000	1290	172000
27	3600	120	16000	360	48000	1350	180000
30	4000	129	17200	375	50000	1440	192000
33	4400	135	18000	390	52000	1500	200000
36	4800	144	19200	400	53333	1650	220000
39	5200	150	20000	405	54000	1800	240000
42	5600	159	21200	420	56000	2100	280000

Feet-Gallons Conversion Table Used in the Meter Department, Battle Creek, Mich., Water-Works.

to the nearest unit, and when the book comes into the office the clerk draws a line through the reading and inserts one that comes so as to make even thousand gallons taken from the table. Where the exact amount is not in the table a simple addition or subtraction gives it.

I send a sample leaf from our meter books. Each book has 30 to 60 leaves and has a cover of black morocco with stiff back and limber front. It is numbered in the front and at the fold, or back, in gold letters. The cover opens at the end and in the back cover near the fold are two brass eyelet holes, corresponding to the two holes punched in the leaves. A tape or cord is put through the eyelets and holes in the leaves and tied on the outside of the cover, the leaves first having been arranged in the order in which the man would most naturally read the meters

as he goes from house to house in a particular neighborhood.

If a new meter is put in, the string or tape is untied and the leaf put in its proper place. If the book becomes too large a rearrangement is easy, as it only requires taking out the tape and the book can be reduced by putting some of the leaves in other books or forming a new one. We have tried several kinds of books but think the ones here described far superior to those used previously. There are others equally good, no doubt, but none have been mentioned in the "News" or other journals that appear to us as good.

The feet-gallons conversion table inclosed by Mr. Bridgen is reproduced in the accompanying cut. The meter rates are printed on the same sheet as the table for convenience, and are as follows:

Thousand gallons.	Cts. per thousand.	Thousand gallons.	Cts. per thousand.
2 to 15	13	150 to 300	10
15 to 30	12	300 to 900	9
30 to 150	11	Over 900	8

The book used by the meter reader has at the head of its pages the name of the occupant of the building where the meter is located, the street number, the make and number of the meter, whether it is owned or rented by the consumer, and directions for entering the building and finding the meter.

From the report of the water-works for 1895, it appears that of 1,669 taps in use on Dec. 31, there were 990, or 59%, metered, but only 34% of the water pumped passed through these meters.

The minimum annual meter rate is $3, and meters are sold to consumers at cost or rented at an annual charge of 15% of their cost.

EXTENSION OF A COVERED WATER-WORKS RESERVOIR AT VIENNA.*

When, in 1891, certain outlying districts were incorporated with the city of Vienna an enlargement of the water-works became necessary.

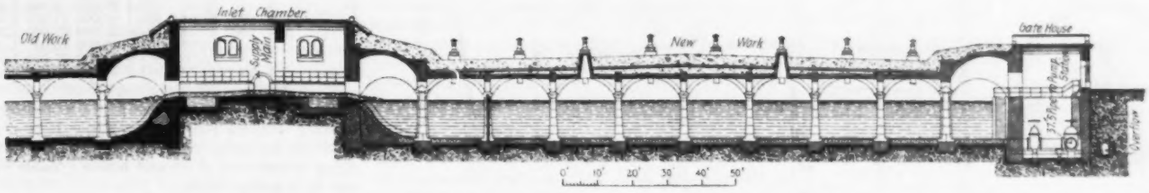
The main distributing reservoir is that at Rosenhuegel, and to this a third extension is being added, as shown in the accompanying section; from this reservoir the water is carried through 37½-in. mains to the reservoirs at Schmelz and Wienerberg, and to the projected pumping station in Breitensee. At this station, which is reached by gravity, it is pumped up into two new reservoirs on a level of about 900 and 880 ft., respectively, above the Adriatic Sea. The level of the Rosenhuegel reservoir is about 800 ft. This part of the supply is specially intended for the high level service of the outlying districts.

The third extension of the Rosenhuegel reservoir is 220 ft. wide by 637 ft. long, inside measurements, and its capacity 10,470,000 gallons. By means of a central wall it is divided into two parts, one of which, or both, may be used at a time. The interior submerged surfaces of the enclosing walls, as well as the bottom surface of the reservoir, are finished with a coating of smooth and hard Portland cement. This insures perfect water tightness and prevents the accretion of sand and slimy particles.

The arched roof of the reservoir rests on 234 granite pillars. The natural foundation is very good, and the footings of the walls, built of quarry stone, are therefore only carried down to a depth of about 40 ins. under the bottom of the reservoir. This bottom is made of two thicknesses of brick, crossing each other diagonally, and upon which is laid a floor of concrete 17¾ ins. thick, finished with a coating of cement, as mentioned above. The bottom slopes slightly towards the outside wall, where there are six openings provided for a complete drainage; the main outlets for emptying the reservoir are, however, in the conduit house.

The whole is covered with a roof of brick arches, in which conical openings, covered with glass, are provided for the purpose of lighting the interior. Special openings are provided in the front walls for ventilation and to allow the air to escape when the reservoir is being filled. The water enters through an inlet on the side, over which a chamber is built, and by means of iron gates it is let into either the one or the other of the two halves of the reservoir. By means of guide walls built between the pillars the water is kept moving in a serpentine line, whereby stagnation at dead corners is prevented as much as possible. On both sides of the conduit house are semi-circular overflow chambers, through which the water is carried off as soon as it rises above a certain level in the reservoir. In order to eliminate the influence of the outside temperature and to keep out rain water, the arches of the roof are covered, first with a compact layer of small broken stone, next with brick, and then with a layer of concrete 6 5-16 ins. thick; finally the whole is protected through a covering of sod. The construction of the reservoir is conducted according to the plans and under the supervision of the Department of City Works. It is to be completed by Oct. 1, 1896.

*Translated from the "Journal of the Austrian Society of Engineers and Architects" by O. J. Marstrand, M. Am. Soc. C. E.



SECTIONS OF COVERED RESERVOIR UNDER CONSTRUCTION FOR THE WATER-WORKS OF VIENNA, AUSTRIA.

THE WATER SUPPLY SYSTEM OF OGDEN, UTAH.

By W. P. Hardesty, C. E.

Ogden is located on the west side and at the base of the Wasatch Mountains, and the Ogden River issues from its canyon in the mountains and flows westerly through the north part of the city. The city had begun growing very rapidly in 1889, and the necessity for a new water supply system was very apparent. The old system was owned by the city, whose limit of bonded indebtedness had nearly been reached, and any new system had to be constructed by private capital.

A brief description of the old system may be in order. The first attempt to provide any water for the city consisted in piping a spring on 24th St., near Adams Ave., and near the present business center, giving a head of about 40 ft. on the main street. Early in the eighties the city put in a regular system, consisting of some 14 miles of Wyckoff piping, which was composed of bored logs wrapped spirally with flat bands.

This system had three separate sources of supply, namely: A 12-in. pipe terminating in a 10-in. pipe diverting a portion of the flow of Ogden River, some four miles from the center of the city. Another line of 4, 6 and 8-in. pipe tapped the waters of Strong's Canyon, distant nearly three miles from the center of the city. A 4-in. feeder from this line led up into Waterfall Canyon near by, from which a small flow was obtained. These two canyons come directly down the western slope of the mountains, just east of the city. The two main lines emptied into a reservoir of small capacity, rectangular in shape, with vertical walls built of rubble laid in lime mortar and coated ½ in. thick with cement, while a small bank of earth surrounded the walls. This was not durable, a frost soon bursting off the cement coating, so that the water leaked through the walls. From the reservoir a system of the same wooden piping was laid through the main streets. The pipe was not well made, apparently, as it soon gave out. The lumber used was not durable, containing many knots, and the thin bands of hoop iron not properly coated, as many of them were found to be rusted entirely through after being in the ground less than eight years. Where the wood was kept continuously saturated by the pipes being always full, it was perfectly sound.

Some 50 hydrants of 4 and 6-in. connections and about 800 taps completed the old system, which had a fire pressure in summer during long lawn-sprinkling hours of only 20 to 30 lbs. per sq. in.

The population of Ogden in 1890 was 14,889. Its area is now about 22 sq. miles, of which only about one-third is well built up. The supply of water required per capita was estimated at 200 gallons per day.

In 1889 the Bear Lake & River Water-Works & Irrigation Co. secured its franchise from Ogden, paying $1 therefor. For three years the rates were to be 10% less than the then existing rates. At the end of the three years a reduction of 10% was to be made, and at the end of the second three years a further reduction of 10% was to be made. The city obtained free water for public squares, lawns, fountains, city buildings, school houses, watering troughs, sewer flushing and street sprinkling. It agreed to pay the company $75 each for the first 100 fire hydrants and $60 each for all over that number.

The company selected as chief engineer for the new water-works system, Samuel Fortier, hydraulic engineer, of Colorado, who had been for years connected with the Denver water companies. The old idea of an open canal was abandoned, and surveys begun early in February, 1890, for a pipe line. As there is included within the limits of Ogden a range of surface elevation of some 450 ft., the limits extending to the base of the mountains in the east, it was found necessary to tap Ogden River at the head of Ogden Canyon, some eight miles from the center of the city. The supply system consists essentially of a 24-in. pipe conduit 29,300 ft. long, which discharges into reservoirs on Nob Hill at the base of the mountains in the eastern part of the city, from which a distributing main carries the water to the center of the city. The water is diverted at the mouth of Wheeler's Creek on the south side of the river.

The river runs through the canyon for nearly five miles with an average fall of 80 ft. per mile, before leaving the mountains. Most of the canyon has steep rocky sides after getting up a short distance above the bottom, and construction in it is difficult. Water is diverted from the river by a very simple inlet and discharged into a masonry gate-house a short distance below, where a feeder from Wheeler's Creek also discharges.

The water from each of the 24-in. inlet pipes is controlled by cheap wooden gates. The outlet to the pipe leading to the city is by an iron valve.

The 24-in. pipe leading to the city has a hydraulic gradient of 14 ft. per mile, with a capacity of 15 cu. ft. per second, or about 10,000,000 gallons per day. The line is on the south side of the creek for about 2,000 ft., when it croses to the north side by a 72-ft. Howe truss bridge. After following this side for 1⅝ miles it recrosses to the south side by another Howe bridge and remains on that side.

For over two miles from its head the pipe is laid mostly along the alluvial bottom of the canyon, then it is run up the hill side and follows fairly closely the hydraulic grade line for over 1¼ miles, then descends to the bottom again to avoid the rock cliffs and follows it for 1⅛ miles, after which it lies on the hillside again. The conduit consists of 20,900 ft. of wooden stave pipe, 4,650 ft. of No. 12 B. W. G. and 3,750 ft. of No. 10 B. W. G. wrought iron riveted pipe.

The wooden pipe is of Allen's patent, and is built of California redwood, banded with ½-in. round steel bands, and has a maximum head of

72 ft. About 95% of this pipe is below the hydraulic gradient, so that, although the pipe does not run up to its full capacity, the wood in this part is kept continuously saturated. The maximum head on the iron pipe is 270 ft.

Part of the joints of the iron pipe were made by riveting, the remainder by the Moore and Smith joint, as furnished by the Risdon Iron Works, of San Francisco. The iron pipe and staves for wood pipe had, on the hillsides, to be hauled through the narrow cut for the trench, and a small car 25 ins. wide in the clear was used, the horses being hitched tandem to this. In the very steep places a block and tackle was used instead of horses.

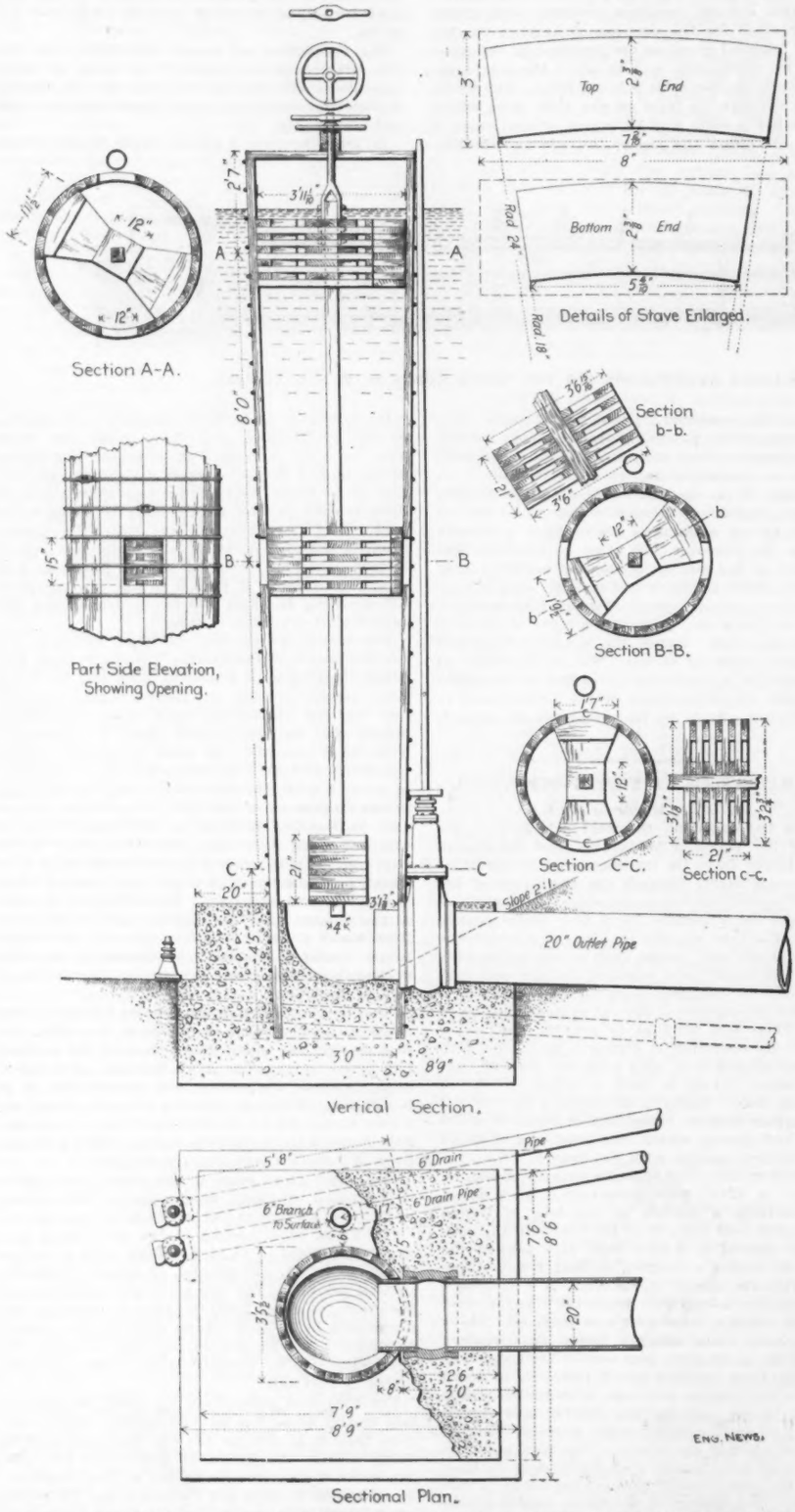


FIG. 1.—VALVE CHAMBER FOR EFFLUENT PIPE, NOB HILL RESERVOIR, OGDEN WATER-WORKS.
S. Fortier, Chief Engineer.

TABLE I.—Estimates of Capacity, Material Required and Cost for 1,000 ft. of Wooden Stave Pipe, Under Varying Conditions.

Diam. in inches.	Fall per 100 ft.	Dip. ft.	—Discharge— Cu. ft. per sec.	—Materials— Inches.	Wood, ft. B. M.	Iron, lbs.	—Cost— Redwood.	Colorado pine.
16....	½	10	1.61	63.9	11,000	2,500	$570	$410
16....	2	100	3.33	127.9	11,000	4,300	642	482
16....	4	150	4.70	180.5	11,000	6,250	720	560
24....	½	10	4.59	176.3	16,000	3,500	830	588
24....	2	100	9.18	352.6	16,000	8,400	1,026	784
24....	4	150	12.98	498.5	16,000	11,750	1,160	918
36....	½	...	12.66	485.8	23,000	5,000	1,190	844
36....	2	70	25.30	971.6	23,000	11,400	1,446	1,100
36....	4	125	35.78	1,373.7	23,000	19,800	1,782	1,436
48....	½	...	25.97	997.3	29,000	9,600	1,634	1,196
48....	2	50	51.94	1,994.7	29,000	17,275	1,941	1,503
48....	4	100	73.45	2,821.0	29,000	32,500	2,550	2,112
60....	½	...	45.37	1,743.0	36,000	16,000	2,190	1,650
60....	2	50	90.73	3,485.0	36,000	27,400	2,640	2,196
60....	4	100	128.40	4,931.0	36,000	50,000	3,550	3,010

Tables I. and II. were used by Mr. Fortier in designing wooden pipe lines. Table I. is a general table for the capacity, material required and cost of pipes of different sizes and heads. Table II. is for use in spacing bands.

The blow-off valves varied in size from 2 to 12 ins., which latter size is found to be much too large on account of the excessive vibration at the low points. Two kinds of air valves were used. The automatic air valves made by the Ludlow Valve Co. were used to free the pipe of small volumes of accumulated air, and a large valve made by the Risdon Iron Works was used to prevent the pipe from collapsing when a sudden break produced a vacuum.

The Nob Hill reservoir is situated at 22d St. and Buchanan Ave. It is an open earth reservoir, and has capacity of 6,500,000 gallons. The bottom is 96×238.6 ft. The inside slope, on three sides, is 2 to 1, and on the east side (mostly in cut) is 1¾ to 1. The depth of water is 21½ ft., with 3 ft. more to top of banks.

The top of bank is 20 ft. wide, with 2 to 1 slope on outer side in the fills. The inside slope is planked with a layer of 2-in. plank, extending from the top of the bank down a distance of 10 ft., to prevent the bank from washing by the waves. The 24-in. inlet wooden pipe extends across the reservoir, and has its top, which lies a few inches below the surface, pierced by 90 holes, each 2½ ins. in diameter, thus securing an excellent circulation.

An admirable feature of the supply to the reservoir is the simple means by which it is regulated, and no water wasted. About ¾ mile up the pipe line, and where it begins to leave Ogden Canyon, an overflow is put in. This consists of a rectangular opening in the top of the pipe, around which a redwood box is built, having a partition near one side, composed of flash boards. By removing part of these the excess water falls over into that side of the box and escapes through an outlet pipe, which discharges into a gulch, and thence back into the river. This overflow is at about the same level as high water in the reservoir, and by raising or lowering the flash boards a few inches the supply to reservoir is correspondingly varied, and the level in it raised or lowered to correspond. The excess water is thus wasted directly back into the river instead of from the reservoir. This device has given excellent satisfaction, with very little attention.

An escape pipe leads through the south bank of the reservoir, for use in case of need. There is an arrangement by which the supply conduit can be connected directly with the distribution main.

TABLE II.—Band Spacing for 24-in. Wooden Pipe.

Head, ft.	Bands per 100 ft.	Head, ft.	Bands per 100 ft.
5	80	105	379
10	85	110	397
15	90	115	415
20	100	120	433
25	105	125	455
30	110	130	469
35	127	135	487
40	145	140	505
45	163	145	523
50	181	150	541
55	199	155	559
60	217	160	577
65	235	165	595
70	253	170	613
75	271	175	631
80	289	180	649
85	307	185	667
90	325	190	685
95	343	195	703
100	361	200	721

thus not requiring the water to pass through the reservoir.

Fig. I. shows the valve chamber for the outlet pipe from the reservoir. The level of water in the reservoir is 430 ft. above Washington Ave., the main street of the town, and which runs north and south. The parallel streets from here east are named in "Presidential succession" order.

The distribution system of Ogden is divided into three sections or zones. Sec. 1 includes the territory between the reservoir and Taylor Ave.; Sec. 2 that between Taylor and Jefferson Ave., this being the residence part of town; and Sec. 3 includes that between Jefferson Ave. and the railway tracks near the west side of town, this being the business portion. One of the Union Water Meter Co.'s pressure regulators is placed at each of the two places of division between sections, and the pressure at each is reduced from about 90 to 40 lbs. These regulators have given excellent satisfaction.

A 20-in. wrought iron riveted pipe leads west and south from the reservoir to Pierce and 25th Sts., a 20-in. standard wrought iron pipe on to Taylor, then an 18-in. pipe to Quincy, and a 16-in. pipe the rest of the way down 25th St. to Washington Ave. Here the supply main is divided.

In the spring of 1890 the board of directors adopted kalamein pipe for most of the distributing system. All sizes, from 6 to 12 ins. inclusive, were to be protected by the kalamein bath and an asphaltum coat, but the larger sizes were to be treated with asphaltum coat alone. Some of the 20-in. pipe is wrought iron riveted, and some lap-welded; the 18 and 16-in. are wrought iron lap-welded.

The distribution system includes about 26 miles of pipe. There are 100 double-nozzle Ludlow 6-in. fire hydrants, and eight triple-nozzle fire hydrants, all with secondary gates. In the business district they are located approximately 400 ft. apart, and in the residence district some 750 ft. part. The valves used throughout are Ludlow, and the service pipes are generally galvanized iron with some few of extra heavy lead pipe.

The regulators are so placed that an ordinary pressure of 70 to 90 lbs. is carried. This pressure can be increased on three minutes' notice to 125 lbs. in the business and most important residence districts, by opening the regulator at Jefferson Ave. and 25th St. During the extensive fires in June, 1894, at the time of the great railroad strike, water was furnished for 12 to 14 fire streams continuously for a number of hours, and the office record pressure that was maintained during this time shows a variation of less than 15 lbs. By opening both regulators a static head of 185 to 190 lbs. could be created in the business part of the city. The entire system has given excellent satisfaction, with a very small cost for maintenance and operation. The joints of kalamein pipe have given more or less trouble, probably accounted for by the very high pressures occasionally carried in the lower part of the system.

There are about 1,700 consumers, probably about 2,500 families being supplied. But a small part of the city is built up closely, mainly on account of the large size of the blocks, which have much ground in their interiors that cannot be used to good advantage. The blocks are 660 ft. sq.; the streets are mostly 99 ft. wide, and Washington Ave. is 132 ft. The large size of blocks probably lessen the amount of piping in the distribution system, but greatly increase the length of service pipes, as many houses are located in the interior of the blocks.

JACKSON SINGLE-VALVE CROSS-COMPOUND ENGINE.

The cross-compound engine, which is illustrated in the accompanying cut, is remarkable among engines of this type in having but a single valve, which controls the induction and exhaust of steam for both cylinders without the use of pipes, receiver or other forms of passages. This engine is manufactured by the Byron Jackson Machine Works, of San Francisco, Cal., and has been extensively employed in connection with centrifugal pumping plants for irrigation, land drainage, etc.

Fig. 1 is a section through both cylinders, and the valve and Fig. 2 a vertical transverse section. These drawings show the two cylinders, the single valve located between and beneath the two cylinders and all of the steam ports. The arrows indicate the direction the steam is traveling, showing its course as it enters the small cylinder and its route thence through the port and valve chamber into the low pressure, thence into the valve chamber, and finally through the center of the valve to the exhaust at the end of the valve chamber. In other respects the engine presents little that is unusual in its design.

The indicator diagram, Fig. 3, shows the pressures in the two cylinders at each point throughout one complete revolution, and illustrates the steam distribution attained by this single piston valve. The card is not a theoretical one, but was taken from an engine doing actual duty. It will be noted that the expansion, when once commenced in the high-pressure cylinder, is not interrupted until it is exhausted from the low-pressure cylinder. The engine therefore belongs to the "Woolf type," as distinguished from the "receiver" type of compound engines. The back pressure line of the high-pressure card is an expansion line, and corresponds with the steam line of the low-pressure diagram until the cut-off takes place, which is coincident in the two cylinders. Then the curve of the low-pressure diagram changes to correspond with the volume and pressure of the steam in the low-pressure cylinder, and the back pressure line of the high-pressure diagram changes to a compression line.

Another noticeable feature about this engine is illustrated by the diagram of Fig. 4, which

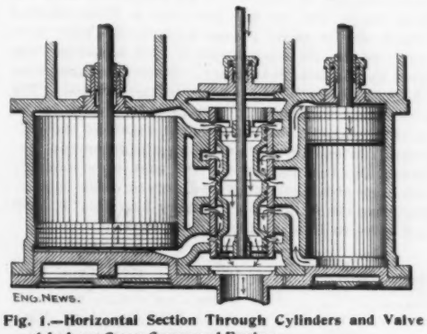


Fig. 1.—Horizontal Section Through Cylinders and Valve of Jackson Cross-Compound Engine.

represents three cards traced one on top of the other. They are actual cards, taken while the engine was running at a uniform speed of 200 revolutions per minute, and the boiler pressure was being raised, starting at 47 lbs. initial pressure in the high-pressure cylinder on the smallest dotted card, and 56 lbs. on the second or solid line card, and ending at 80 lbs. on the highest card, illustrating how the compression changes with the cut-off and boiler pressure, and always reaches, or nearly reaches, the initial steam

Fig. 2.—Vertical Cross-Section Through Cylinders and Valve of Jackson Cross-Compound Engine.

line, thus always filling the clearance space with the steam trapped in.

The cards above referred to show a theoretical consumption of 13 lbs. of water per HP. per hour. They were taken from an engine having cylinders 12 and 22 × 16 ins., running at 200 revolutions per minute, the larger card, Fig. 3, indicating over 200 HP. The engine was running two 30-in. centrifugal pumps, pumping 40,000 gallons of water per minute, against a head of 50 ft. and through 200 ft. of 30-in. pipe on each pump. The three sets of cards, traced one over the other, Fig. 4, were taken from the front end of each cylinder with one indicator, using a 40-lb. spring, and both high and low pressure diagrams are on one card, taken one immediately after the other. The engine, when these cards were taken, was driving only one pump, and indicated a trifle more than half the power required when driving both pumps.

In an actual service test of one of these engines operating a centrifugal pump, made by Mr. John W. Ferris, Engineer of the Swamp Land District No. 3, Sacramento Co., Cal., the following results were shown:

Fig. 4.—Three Sets of Cards from Single Valve Cross-Compound Engine, Traced one over the other, Taken from Front End of Cylinder, Showing Both High and Low Pressure Diagrams.

Fig. 3.—Indicator Card Showing Steam Distribution of a Single Valve Cross-Compound Eng.ne.

M. E. P. each high pressure card	24.48
M. E. P. each low pressure card	10.24
Total M. E. P. reduced to low pressure	17.64
Total horse power	108.6
Initial pressure	47lbs, 56lbs, 80lbs
M. E. P high pressure cylinder	39.92
M. E. P. low pressure cylinder	21.66
Total M. E. P. Reel to low pressure	33.63
Total Horse Power	205
Initial pressure	96

Engine; cross-compound condensing:	
Diameter high pressure cylineder	13½ ins.
Diameter low pressure cylinder	25 ins.
Length of stroke	16 ins.
Boiler, horizontal tubular:	
Size of boiler	16 ft. × 66 ins.
Size of tubes	3½ ins.
Number of tubes	78
Area heating surface	1,270 sq. ft.
Area grate surface	25 sq. ft.
Av. lbs. coal burned per sq. ft. per hour	18 lbs.
Steam pressure	120 lbs.
(Air pump and boiler feed pump driven by belt.)	
Vacuum	27 ins.
Revolutions of engine per minute	160
Indicated horse power	210.45
Coal consumption per hour	450 lbs.
Diameter pump shell	12 ft.
Diameter pump runner	4 ft. 10 ins.
Diameter suction pipe	44 ins.
Diameter discharge pipe	44 ins.
(Discharge pipe under water forming siphon.)	
Difference in water level	10¾ ft.
Friction head due to 275 ft. pipe	1½ ft.
Height of lift	11 ft. 9 ins.
Discharge per minute	41,925 gallons
Work done by pump per minute	4,105,156 ft. lbs.
Duty of pump and engine per 100 lbs. coal	54,735,400 ft. lbs.
Coal consumed per I. HP. per hour	2.14
Efficiency of the pump	59%

In relation to this test the manufacturers write:

We will say that we have made tests with nearly all of our large pumping plants and we have never failed to equal the test reported, which I think is a fair representative test; but with good coal we can make a better showing in coal consumption. This test was made on the regular everyday work, with coal that had been lying out in the rain and was quite wet, and the fireman had had but little experience in firing any kind of coal—was simply an ordinary farm hand.

We are indebted to the Byron Jackson Machine Works, San Francisco, Cal., for the matter from which our illustrations and descriptions have been prepared.

A WATER-TIGHT REVOLVING DOOR for the bulkheads of vessels has been recently patented by Mr. William Kirkaldy, of Glasgow, Scotland, which seems to avoid the dangers consequent upon leaving open the ordinary bulkhead doors. It is described as follows: It consists of a hollow cylindrical door, which revolves within a suitable casing, fixed to, or forming part of, a water-tight bulkhead. By combining this revolving cylindrical door and casing, a double door is formed, which effectually prevents the ingress of fire, water, etc., through the bulkhead, yet on being revolved by hand allows free thoroughfare between water-tight compartments, with the certainty that at all times one of the doors is absolutely closed. When the doorways in the casing and the revolving cylindrical door are in line, free passage through the bulkhead is gained by entering and standing inside of the casing and revolving the door by hand, when the ingress doorway in the casing is absolutely closed before the doorway in the revolving door comes in line with the second doorway to allow egress from the casing. In the event of a collision there is absolutely nothing to be done in the way of closing the water-tight doors. As the doors are never open, no gearing is required to close them, thus obviating the necessity of bulkhead drill, and allowing the crew to perform other urgent work.

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The production of electric energy by the direct combination of carbon and oxygen is said to have been accomplished by Dr. W. W. Jacques, of Boston, on a scale and with an efficiency which promises commercial success. According to detailed reports in the Boston newspapers, the process consists in immersing carbon in a bath of fused caustic soda and causing air to bubble through the liquid. In the terms of the inventor's patent application: "I have found that if oxygen, whether pure or diluted as in air, be caused to combine with carbon or carbonaceous materials, not directly as in combustion, but through an intervening electrolyte, the potential energy of the carbon may be converted directly into electrical energy instead of into heat."

Tests of the invention are said to have been recently made by Prof. Chas. R. Cross, of the Massachusetts Institute of Technology, and Stone & Webster, Electrical Engineers, of Boston. The apparatus consisted of 100 iron cells, each 12 ins. deep and 1½ ins. in diameter. These were grouped over a grate and filled with caustic soda (Na O H) which was fused by a fire beneath. The cells were connected in series, one wire being attached to the iron cell and the other to a carbon immersed in the electrolyte. The current obtained was sufficient to light 30 16-c. p. lamps, the average potential being 90 volts and the quantity 16 amperes. In 18¾ hours the carbon consumed was "about 8 lbs.," and the report states that 82% of the theoretical potential energy of the carbon was converted into electrical current. We have checked this from the figures and find it correct, on the assumption of 14,000 h. u. per lb. of carbon.

The heat used to fuse the electrolyte was not taken into account, as the amount of fuel used for this purpose would vary of course with the size of the battery. Neither was account taken of the amount of power used in forcing air into the electrolyte. But both of these are proper matters for determination only in a commercial plant.

Dr. Jacques is said to have studied at Johns Hopkins and in Europe, and to have been in the employ of the Bell Telephone Co. for many years. Prof. Rowland, of Johns Hopkins, is also said to have vouched for the genuineness of the invention.

The high authority of Messrs. Cross, Rowland, Stone and Webster, will be recognized by all; and if it is, indeed, true that 82% of the potential energy of carbon can be converted into electrical current by means so simple, the importance of the invention cannot be overestimated. It would create revolutions greater than those made by any invention ever known. But every engineer will wish to learn more of the invention before passing judgment upon it. That ordinary carbon should unite directly with atmospheric oxygen at a temperature of only some 300°, merely because of the presence of an alkaline bath, will strike most chemists, we believe, as a very strange proceeding. We hope some of our readers who have the necessary facilities at hand will make one of Dr. Jacques' cells in the manner described above, measure the current produced and let us know the results. Meanwhile we shall endeavor to secure more information respecting this invention.

According to a letter published in another column, 45% of the ultimate strength is as high a requirement for the elastic limit as may safely be required in steel castings. It is noticeable that the tests on which this conclusion is based were made on test pieces of the standard length of 8 ins. The results, therefore, should correspond more certainly with the results of tests on rolled steel than is the case with test-pieces of shorter lengths.

The pig iron statistics collected by our enterprising contemporaries the "Iron Age" and the American "Manufacturer," and published once a month, are of interest to all connected with the iron trade, but we are just now a little puzzled which one of these papers to believe. The "Iron Age" begins its report with a bold headline "Pig Iron Production Stationary," while the American "Manufacturer" has an editorial headed "Pig Iron Again Increasing." Turning to the figures of weekly capacity of furnaces in blast at the different dates we find a wide disagreement between the two papers for the last nine months, although previously they had agreed quite closely. Here are the figures for January 1 to May 1, 1895 and 1896, in thousands of gross tons:

1895.	Jan. 1.	Feb. 1.	Mar. 1.	April. 1.	May 1.
"Iron Age"	168.4	163.4	157.0	158.1	156.6
American "Manufacturer"	175.3	159.0	153.8	154.5	153.3
Difference	+ 6.9	— 4.4	— 3.2	— 6.6	— 1.3
1896.	**Jan. 1.**	**Feb. 1.**	**Mar. 1.**	**April 1.**	**May 1.**
"Iron Age"	207.5	198.6	189.6	187.5	188.3
American "Manufacturer"	235.4	217.3	212.7	211.6	214.7
Difference	27.9	18.7	23.1	24.1	26.4

Several years ago we published for some time "Notes from the Engineering Schools," occasional articles in which were given news of interest respecting the work being carried on in the various engineering schools, changes in the methods in use, the courses of instruction, the personnel of the faculty, or improvements in buildings or apparatus. We have decided to resume the publication of notes under this heading at occasional intervals. The value and the interest which these notes will possess will depend very largely on the extent to which our friends in the engineering schools will co-operate with us by sending us information concerning matters in their own schools. While we do not expect to devote a large amount of space to this department, we believe that the current progress in the engineering schools is of sufficient importance and interest to the active members of the profession to deserve mention from time to time in our pages, and we trust that our friends in the schools will co-operate with us in our attempt.

We have been informed that one W. Lodian has been traveling in India and other countries of the Far East, representing himself to be a special correspondent of this journal, and soliciting transportation and other favors as our representative. We would state that Mr. Lodian has no authority from us to represent us in any way; and is not and never has been in our employ. He has sent us some photographs at various times during his travels, as he has also to other American engineering journals, but has done so on the same basis as any other voluntary contributor. With one or two exceptions none of the matter received from him has been available for publication. We warn all persons not to extend him favors or furnish him transportation on our account.

TYPHOID FEVER AND WATER SUPPLY IN 66 AMERICAN AND FOREIGN CITIES.

The relation between typhoid fever and water supply is now recognized as being so close that a continued high typhoid mortality in any city is taken as pretty conclusive evidence that the public water supply is polluted with sewage. In accordance with this view, Mr. John W. Hill, M. Am. Soc. C. E., has brought together some facts regarding the typhoid death rate and water supply of 66 American and foreign cities.* This information furnishes such a powerful argument for pure water and shows so conclusively the backwardness in this respect of many American as compared with foreign cities that we reproduce two of Mr. Hill's tables herewith. Table I. shows the source of water supply and the yearly and average typhoid mortality per 100,000 for the past five years in 32 cities of the United States, one Canadian city and 33 foreign cities, most of the latter being European. The cities are arranged by classes in accordance with the average mortality for the five years, 1890 to 1894, inclusive. A re-classification on the basis of the mortality for 1894 is made in Table II., this being considered desirable on account of improvements in some of the water supplies during the period.

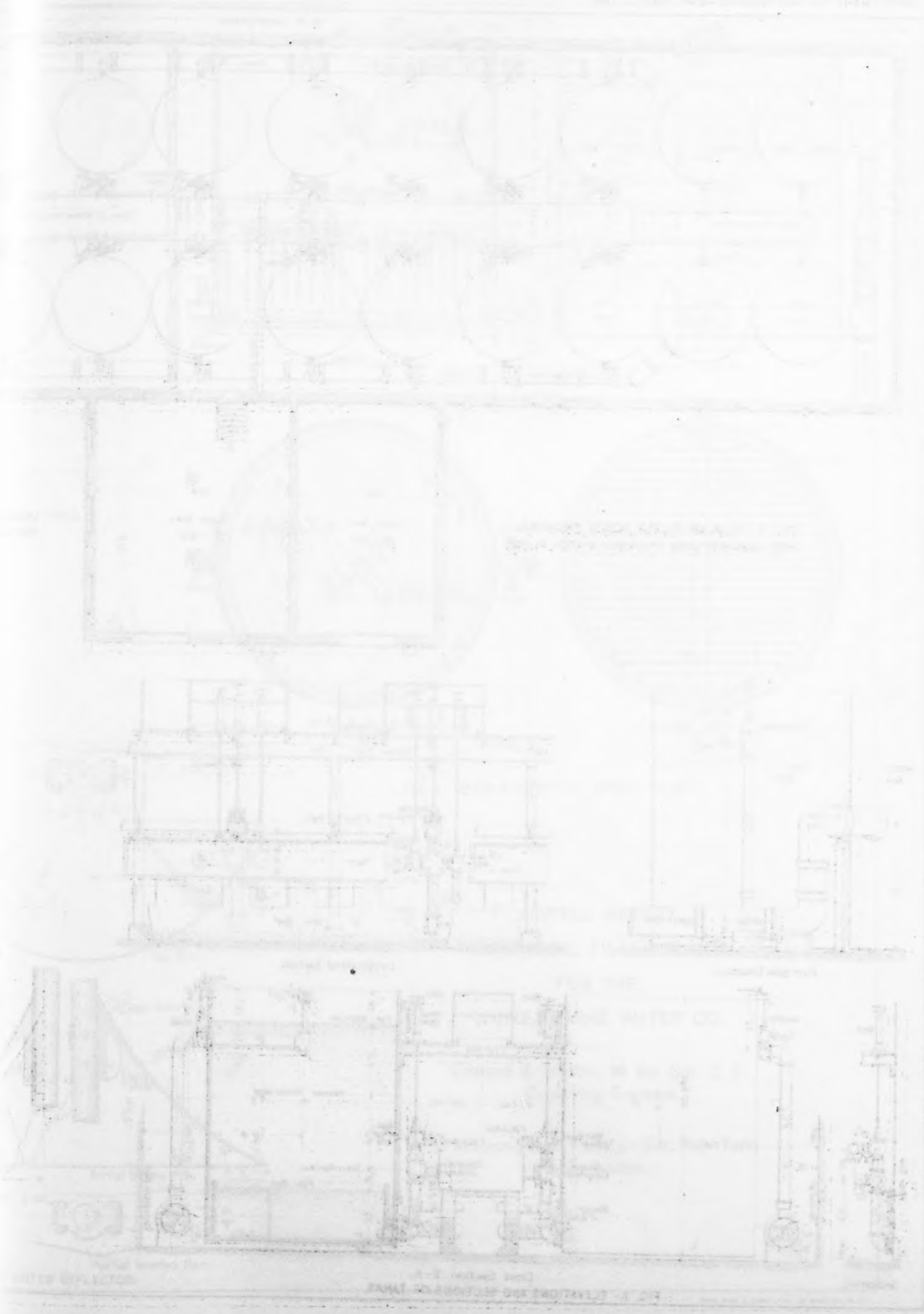
It will be noticed in Table I. that among the cities with the lowest typhoid mortality 15 foreign names appear before an American one is seen, and that all these cities either have filtered water supplies or draw upon some source above suspicion as respects pollution. The first two American cities named, Brooklyn and New York, have supplies long noted for their purity. The third American city, Davenport, has had a filtered supply since June, 1891, but the company furnishing it has claimed that filtration was adopted to remove sediment and not organic impurities. In the whole first half of the list, including cities having a typhoid mortality of 36.8 per 100,000, or less, there are but eight American cities, out of a total of 33, while in the last half there are, including Toronto, 26 out of 33. In the first 16 cities there is but one American name, and in the last 16 all but four are American.

The averages are manifestly unfair in a number of cases, notably for Hamburg, Newark, Lowell, Atlanta and Lawrence, where improvements in the water supply have been made since 1890, accompanied by a marked decrease in the typhoid death rate. To give these cities a better showing Mr. Hill has re-arranged them according to the 1894 figures. This is misleading in some cases, as the figures for a single year may be abnormal in either direction, but still something is to be gained by the new classification, especially as the general tendency is to a lowering of the death rate, 51 out of the 66 cities showing a mortality for 1894 below the average for the period.

The new grouping in accordance with the 1894 figures leaves Brooklyn at the head of American cities, but places two more foreign cities in advance of those on this side of the water. Newark comes up from No. 42 to No. 19, ranking just ahead of New York. Hamburg rises from No. 22 to No. 6. Passing to the last of the list, Jersey City falls slightly, but about all that it could, from No. 56 to No. 61, thus ranking next to the two Egyptian cities.

In the communication from Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., and Chief of the Philadelphia Bureau of Water, published in our issue of March 26, a diagram is presented to show that the percentage of typhoid cases proving fatal has diminished during the past few years. We presented figures to show that the number of reported cases per 100,000 had not fal-

*In an address before the faculty and students of the University of Illinois, entitled, "Water Supply for Cities." This address has been printed and copies can doubtless be obtained by applying to the author at Glenn Building, Cincinnati.



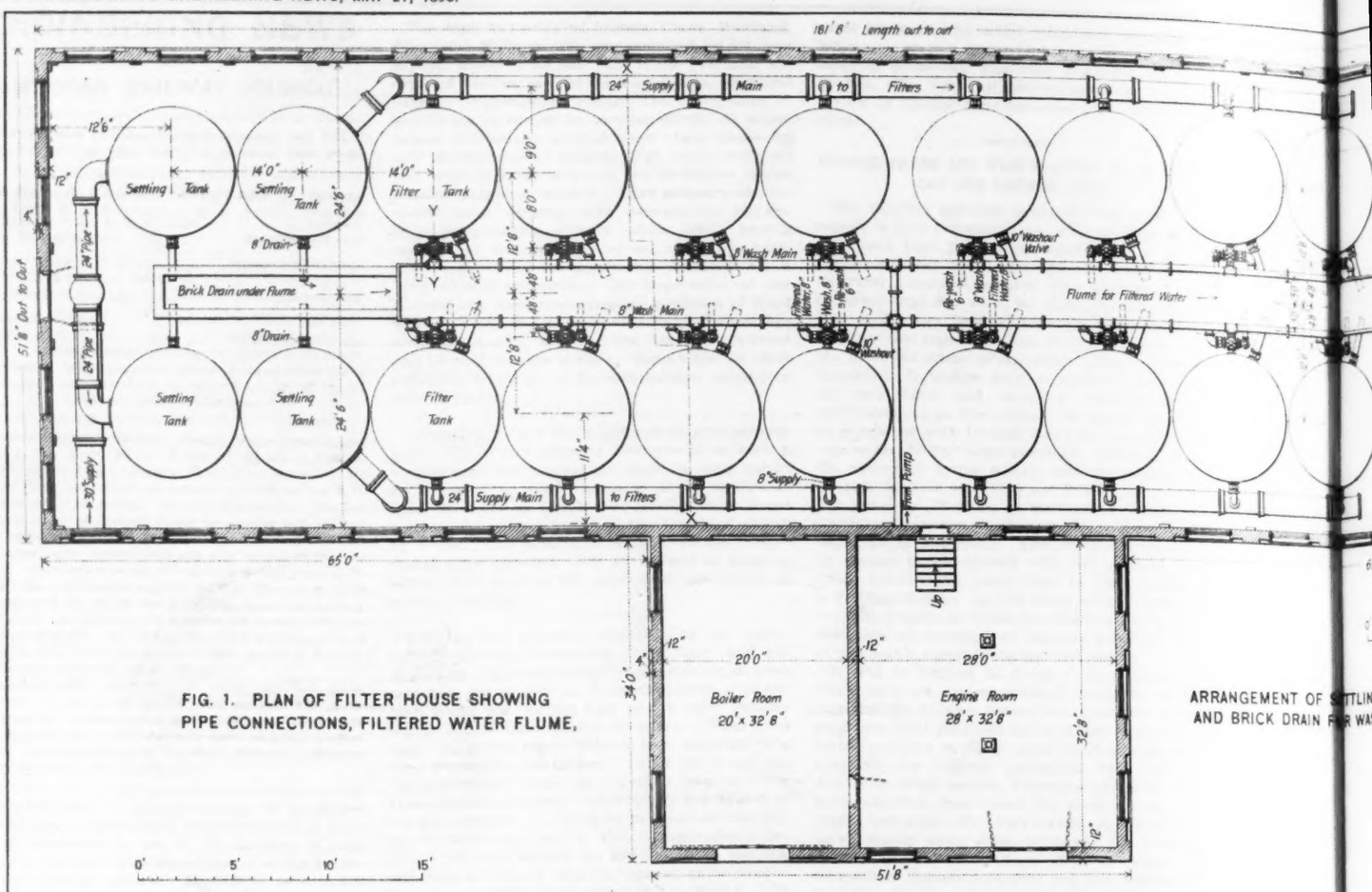
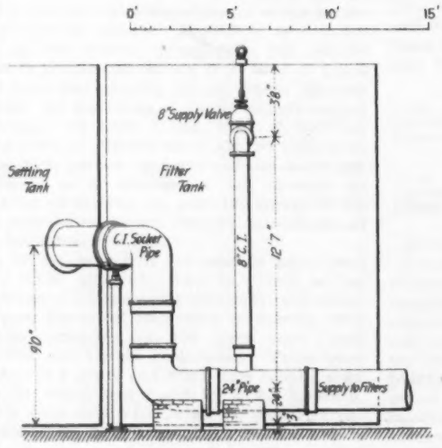
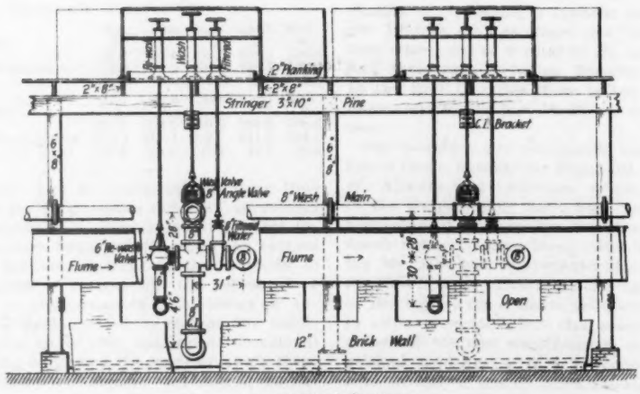


FIG. 1. PLAN OF FILTER HOUSE SHOWING PIPE CONNECTIONS, FILTERED WATER FLUME,

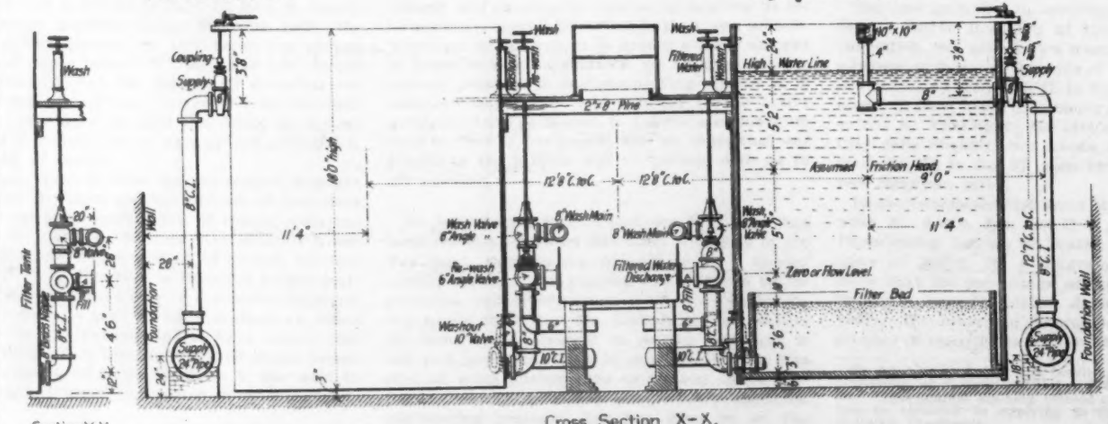
ARRANGEMENT OF SETTLIN AND BRICK DRAIN FOR WA



Part Side Elevation.

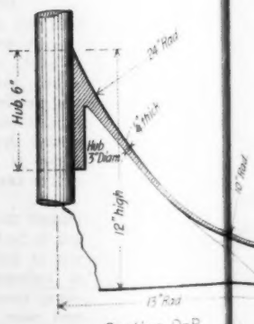


Longitudinal Section.



Section Y-Y.

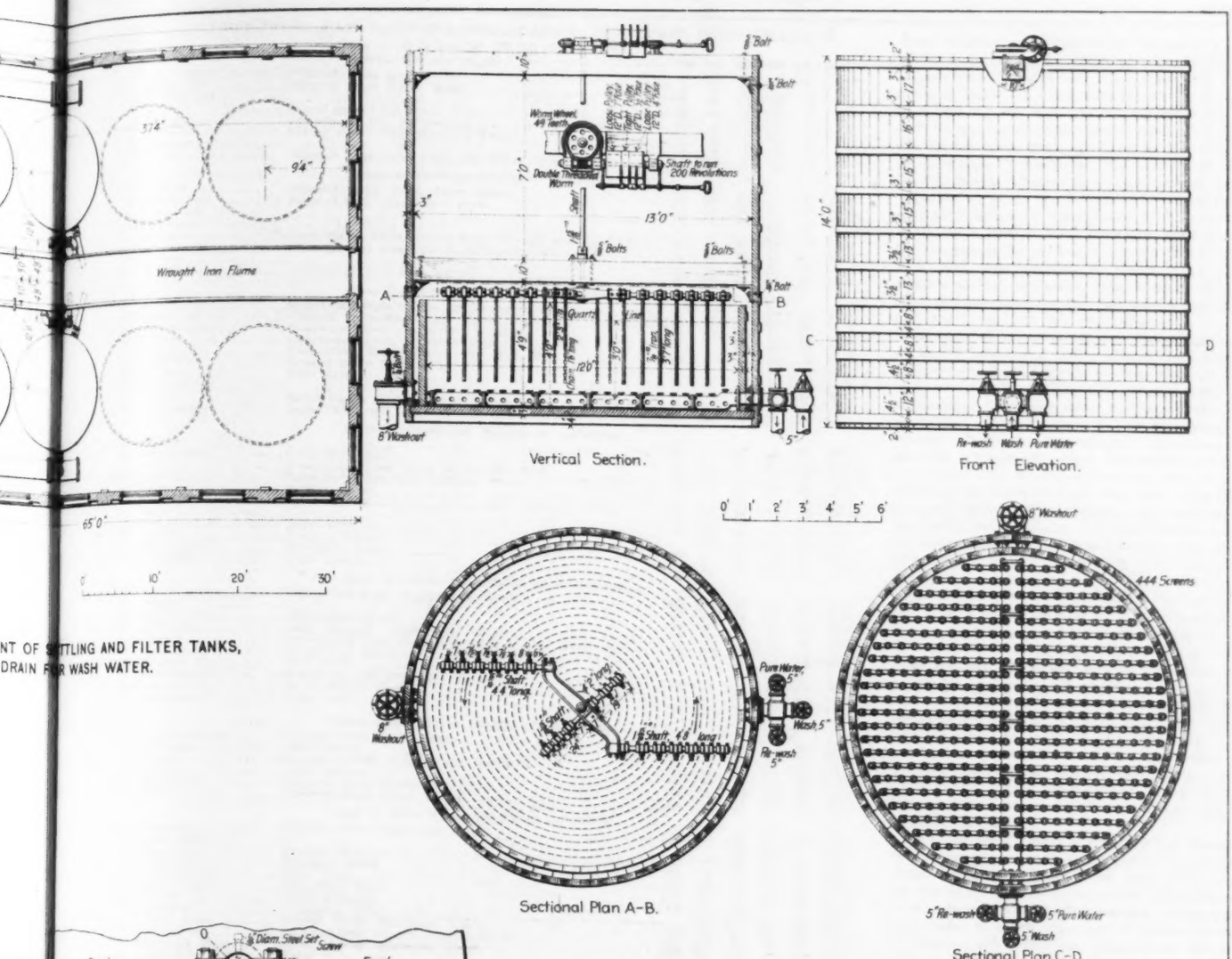
Cross Section X-X.



Section O-P.

FIG. 2. ELEVATIONS AND SECTIONS OF TANKS.

FIG. 4.



NT OF SETTLING AND FILTER TANKS,
DRAIN FOR WASH WATER.

FIG. 3. DETAILS OF TYPICAL JEWELL FILTER.

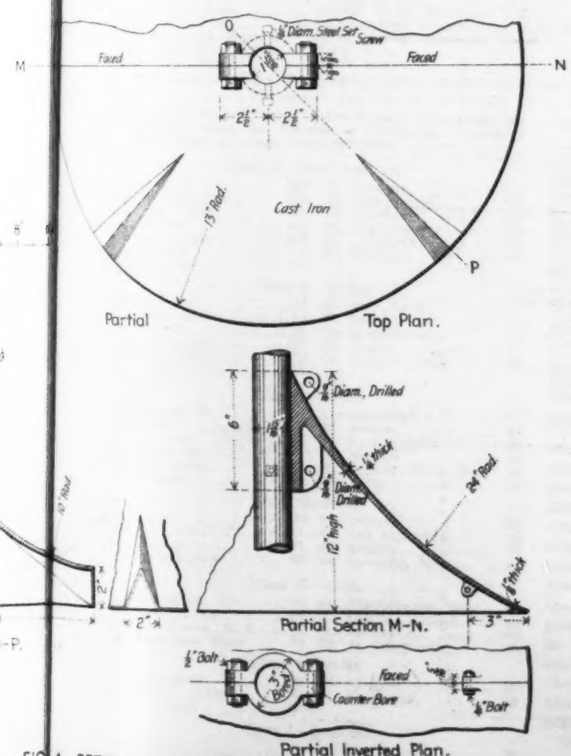


FIG. 4. DETAILS OF WATER DEFLECTOR.

JEWELL GRAVITY
MECHANICAL FILTER PLANT,
FOR THE
WILKES-BARRE WATER CO.

Edmund B. Weston, M. Am. Soc. C. E.,
Consulting Engineer.

Morison-Jewell Filtration Co., New York,
Contractor.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

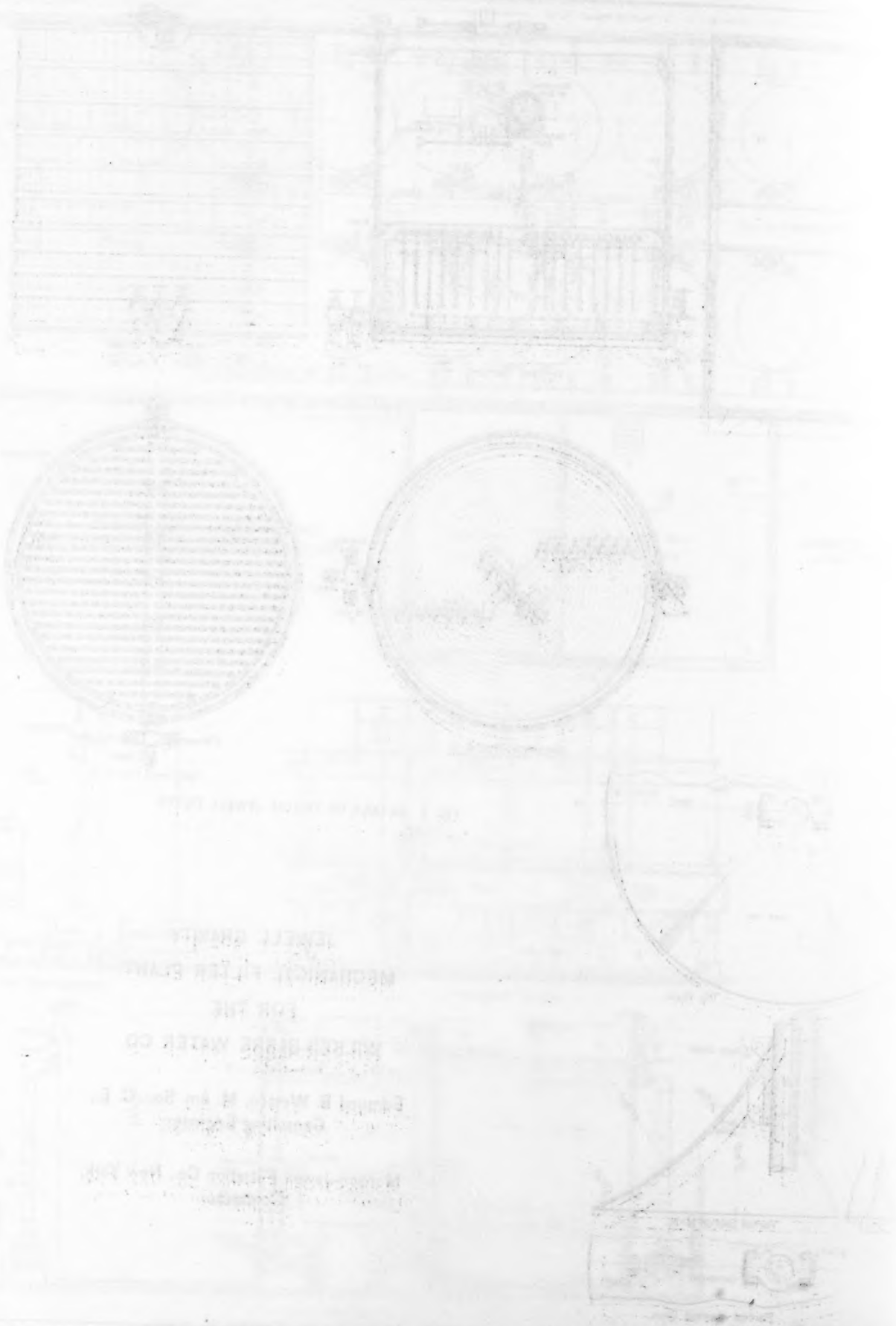


TABLE I.—TYPHOID FEVER DEATH RATES IN AMERICAN AND FOREIGN CITIES, 1890-94, INCLUSIVE.

Class 1.—10 or less per 100,000 of population.

City.	Source of Water Supply.	'90	'91	'92	'93	'94	Av.
1. The Hague	Filtered from sand dunes	3	12	4	2	3	4.0*
2. Rotterdam	Filtered from River Maas	6	4	6	5	5	5.2
3. Christiania		12	9	4	6	3	6.8
4. Dresden	Filter gallery by River Elbe	9	8	5	5	8	6.9
5. Vienna	Springs in the Schneeberg	9	6	8	7	5	7.0
6. Munich	Spring water from Mangfall Valley	8	7	3	15	3	7.1
7. Copenhagen		9	8	7	9	7	7.9
8. Berlin	Filtered from Lake Tegel and River Spree	9	10	8	9	4	8.0

Class 2.—10-20 per 100,000 of population.

9. Breslau	Filtered water from River Oder	15	12	15	10	6	11.6
10. Amsterdam	Filtered from Haarlam Dunes	19	11	15	16	9	13.9
11. Stockholm		18	18	19	8	8	14.3
12. Brisbane		..	..	..	19	10	14.3*
13. London	Kent Wells, 17%; filtered from Thames and Lea, 83%	16	15	11	16	15	14.6
14. Edinburgh	Filtered from reservoir in Pentland Hills	19	18	13	14	15	15.8
15. Trieste		12	11	26	17	19	17.0
16. Brooklyn	Impounded and well water	26	20	17	17	15	19.0

Class 3.—20-30 per 100,000 of population.

17. New York	Impounded from Croton and Bronx Rivers	21	22	22	20	17	20.4
18. Davenport	Filtered from Mississippi River	19	11	35	17	26	21.4*
19. New Orleans	Rainwater from tanks and cisterns	20	23	21	15	28	21.4
20. Sydney, N. S. W.	Impounded from Upper Nepean	..	..	20	19	29	21.6
21. Hamburg	From River Elbe, filtered since May, 1893	28	23	34	18	6	21.8
22. Buda Pesth	Ground water from wells	34	23	26	15	14	22.4
23. Glasgow	Lake Katrine	26	31	18	20	24	27.8
24. Brussels		26	41	23	27	14	26.2
25. Paris	Rivers Seine, Marne, Vanne, Ourcq, Canal, art. wells & sps	30	20	28	25	29	26.4
26. Manchester	Lake Thirlmere	31	39	25	25	18	27.6

Class 4.—30-40 per 100,000 of population.

27. Venice		44	33	30	26	18	30.2
28. Milwaukee	Lake Michigan	33	33	31	37	26	32.0
29. Rome	Fontanadi Trevi, Aqua Felice and Paoli	35	36	26	34	30	32.2
30. Boston	Lake Cochituate and Sudbury River	43	33	29	30	28	32.6
31. Detroit	Detroit River	18	13	51	61	26	33.8
32. Dayton, O.	Driven wells	20	32	44	64	20	36.0
33. Turin		46	41	44	29	24	36.8
34. Liverpool	Lake Vyrnwy	24	25	25	53	58	37.0
35. Buffalo	Niagara River	..	50	34	37	36	39.2
36. Providence	Pawtuxet River	29	47	39	34	47	39.2
37. Covington	Ohio River	43	45	40	27	42	39.4

Class 5.—40-50 per 100,000 of population.

38. San Francisco	Impounded from mountain streams	59	41	34	32	35	40.2
39. Prague		33	37	53	36	57	43.2
40. Minneapolis	Mississippi River	41	45	36	60	45	45.4
41. Baltimore	Lake Roland, Gunpowder River	57	34	42	47	49	45.8
42. Newark	Impounded from Pequannock River since April, 1892	60	81	45	28	15	45.8
43. St. Louis	Mississippi River	34	30	37	103	31	47.0
44. Newport, Ky.	Ohio River	..	..	..	58	37	47.5
45. Philadelphia	Schuylkill and Delaware River	64	64	40	41	32	48.2
46. Denver	South Platte River	..	..	53	57	35	48.3
47. Cleveland	Lake Erie	66	52	54	47	27	49.2

Class 6.—50-60 per 100,000 of population.

48. St. Petersburg	Filtered from River Neva	57	..	..	51	49	52.3
49. Cincinnati	Ohio River	64	62	40	43	59	54.4
50. Moscow	Springs, ponds, Moscov and Yanza Rivers	73	75	68	40	20	57.0
51. Toronto	Lake Ontario	93	94	43	42	17	57.8
52. Quincy, Ill.	Filtered from Mississippi River	76	28	48	58	79	58.0
53. Dublin	Filtered from River Vartry	62	58	39	87	48	58.8

Class 7.—Over 60 per 100,000 of population.

54. Knoxville	Filtered from Tennessee River	101.5	45	37	67	59	61.9
55. Milan, Italy		..	..	62	62	..	62.0
56. Jersey City	Passaic River	91	95	53	60	76	75.0
57. Washington	Potomac River	83	83	70	66	71	76.6
58. Louisville, Ky.	Ohio River	88	81	72	84	72	79.4
59. Chattanooga	Tennessee River	145	66	55	86	48	80.0
60. Chicago	Lake Michigan	83	160	104	42	31	84.0
61. Pittsburg	Allegheny River	..	100	100	111	56	91.7
62. Lowell, Mass.	Driven wells, Merrimac River	158	98	90	61	55	92.4
63. Atlanta, Ga.	Filtered from Chattahootchie River	149	119	87	60	43	92.8
64. Lawrence, Mass.	Filtered from Merrimac River	123	115	102	93	48	96.2
65. Alexandria, Egypt	River Nile	208	348	77	79	100	162.4
66. Cairo, Egypt	River Nile	260	233	163	154	135	189.4

*Not exact averages of preceding figures, as here given, owing to elimination of decimals in yearly figures.—Ed.

TABLE II.—Typhoid Fever Death Rates in American and Foreign Cities, per 100,000 of Population, Arranged Upon Basis of Death Rates for 1894.

Class 1.—Less than 10.

1. Munich	2.5	8. Breslau	6.1
2. Christiania	3.0	9. Copenhagen	6.7
3. The Hague	3.4	10. Dresden	8.2
4. Berlin	4.0	11. Stockholm	8.3
5. Rotterdam	4.8	12. Amsterdam	8.5
6. Vienna	5.0	13. Brisbane	9.6
7. Hamburg	6.0		

Class 2.—10-20.

14. Brussels	14	20. New York	17
15. Buda-Pesth	14	21. Toronto	17
16. London	15	22. Manchester	18
17. Edinburgh	15	23. Venice	18
18. Brooklyn	15	24. Trieste	19
19. Newark	15		

Class 3.—20-30.

25. Dayton, O.	20	31. Cleveland	27
26. Turin	24	32. Boston	28
27. Glasgow	24	33. New Orleans	28
28. Milwaukee	26	34. Moscow	29
29. Davenport	26	35. Sydney, N. S. W.	29
30. Detroit	26	36. Paris	29

Class 4.—30-40.

37. Rome	30	41. Denver	35
38. St. Louis	31	42. San Francisco	35
39. Chicago	31	43. Buffalo	36
40. Philadelphia	32	44. Newport, Ky.	37

Class 5.—40-50.

45. Covington, Ky.	42	49. Chattanooga, Tenn	48
46. Atlanta, Ga.	43	50. Dublin, Ireland	48
47. Providence, R. I.	47	51. Baltimore	49
48. Lawrence, Mass	48	52. St. Petersburg	49

Class 6.—50-60.

53. Cincinnati	50	56. Prague	57
54. Lowell, Mass.	55	57. Knoxville	59
55. Pittsburg	56		

Class 7.—Over 60.

58. Milan	62	61. Jersey City	76
59. Washington City	71	62. Alexandria, Egypt	100
60. Louisville	72	63. Cairo, Egypt	135

TABLE III.—Percentages of Typhoid Mortality to Total Cases, 1890 to 1896, Inclusive, in 18 American Cities.

	1890.	1891.	1892.	1893.	1894.	1895.	Ave.
New York	32	27	35	38	41	33	34
Philadelphia	21	19	19	18	16	17	18
Brooklyn	..	..	..	..	56	56	56
St. Louis	..	31	40	14	21	27	27
Boston	..	16	18	..	15	..	16
Cincinnati	..	60	50	63	22	..	51
Cleveland	39	44	44	54	67	52	50
Buffalo	..	..	..	..	10	..	..
Pittsburg	..	24	22	12	13	13	17
Milwaukee	..	46	39	25	28	..	35
Newark	30	17	38	44	35	..	33
Jersey City	..	..	..	..	70	40	55
Providence	39	32	35	25	27	..	32
Lowell	..	..	..	..	18	..	..
Lawrence	28	26	28	32	..	..	29
Dayton	..	..	..	..	..	13	..
Toronto	17	20	19	16	14	15	17
Denver	..	..	23	46	60	21	38

Table III. gives the percentages which typhoid mortality bears to total cases in 18 American cities, from 1890 to 1895, inclusive, with averages for the period for each city. From this it will be seen that the percentages range from 10% in Buffalo to 70% in Jersey City, both in 1894, and that the averages for the full period range from 17% for Toronto to 50% in Cleveland.

The figures in Table III. are based on a total of 38,848 cases and 9,530 deaths, indicating on their face that of this vast number of cases nearly 25%, or one out of every four, proved fatal. The averages in the table show approximately a like proportion for St. Louis, 1 to 3 in New York, Milwaukee, Newark, Providence, Lawrence and Denver, while in Brooklyn, Cincinnati, Cleveland and Jersey City, it appears that of every two persons having typhoid fever, one dies. The Brooklyn and Jersey City averages are based on only two years returns. On the other hand a number of other cities in the list shows that the chances of recovery are as 1 to 5 or 6. The "Encyclopedia Britannica" says the mortality in typhoid cases will vary with circumstances, but gives 12%, or, 1 in 8, as its opinion of a fair average. It has been common in discussing the money value of pure water to assume that for every death from typhoid fever there are 10 recoveries which would be one out of 11, or 9%. The report on a new water supply for Cincinnati, mentioned above, assumes one fatal case out of every six. Enough has been said to make it apparent that for the present no safe deductions can be drawn from general statistics of typhoid cases, but that our chief reliance must continue to be on mortality figures. Even these are doubtless very deficient in many cities.

As to increased skill in treating the disease, in recent years, perhaps the period covered is too short for any conclusions on this point, even if all the cases had been reported. The record as it stands indicates a diminishing percentage of fatal cases in seven cities out of twelve for which the figures are sufficiently complete to throw any light on the subject, but in some of these the decrease is small.

Jen at so great a rate as the deaths, during the period covered by the diagram. We also suggested that perhaps the cases had been more fully reported of late than formerly. If physicians are becoming more skillful in treating this disease, as suggested by Mr. Trautwine, or if the people in a community where typhoid is prevalent gradually become more able to resist the disease when contracted, as was recently suggested by Mr. Rudolph Hering, M. Am. Soc. C. E., in conversation with a member of the editorial staff of this journal, then obviously statistics of cases of typhoid fever would be of great importance in studying the relation between water supplies and typhoid fever.

Unfortunately it appears from such information as is at hand that non-fatal cases of typhoid fever are so poorly reported in most cities of this country that statistics respecting them are of doubtful value. This, at least, is the conclusion which we should draw from the figures given in Table III. This table has been computed from one by Mr. Hill, embodying more information for the same cities than is given in Table I., the larger table being printed in the report of the Engineer Commission on a new water supply for Cincinnati, abstracted in our issue of April 2.

LETTERS TO THE EDITOR.

Another Newspaper Fake.

Sir: The old adage that one has to go away from home to learn what is going on at home is well illustrated in the item in your last issue headed "Duluth, Winnipeg & Hudson Bay Canal." This canal exists only in the imagination of some reporter for some Eastern papers. No such company exists or has such a scheme in view.

Yours truly, E. J. D.

Duluth, Minn., May 12, 1896.

(There have been so many chimerical canal schemes in the air in the Northwest during the past year or two that it is a little difficult for us to distinguish between those which exist only in the imagination of newspaper correspondents, and those which exist only in the imagination of "promoters."—Ed.)

Shipping Long Timbers by Rail.

Sir: I note in your issue of April 30, in speaking of long piles which are being driven at Tacoma, Wash., you remark that "sticks 90 ft. long are being shipped east, and it is expected that changes in the line of railway will soon permit shipping 100-ft. lengths."

The Great Northern Ry., in operation between Puget Sound and St. Paul, has already shipped sticks 115 ft. to 125 ft. in length, without the slightest difficulty.

Truly yours, Jno. F. Stevens,
Chief Engineer, Great Northern Ry.

St. Paul, Minn., May 9, 1896.

The Principles of Fireproof Construction.

Sir: Mr. Rossi, in your issue of May 14, describes some tests performed by Mr. Constable with results in his opinion so noteworthy that he considers the conclusions

of the articles on the "Art of Fireproofing" (Eng. News, April 9 and 16, to be completely controverted. I will allow that for a small furnace, such as Mr. Rossi describes, intended to hold a charge of wood until the same is consumed, the tile arch is a suitable construction when built with care and of the best materials. Mr. Rossi, however, would have us accept the test house as a standard and discard the actual house and fire as an irrelevant matter involving poor material and construction and doubtless an altogether improperly behaved fire. The articles on the "Art of Fireproofing" differ from Mr. Rossi, not in disputing the adequacy of well constructed test houses, but in calling attention to the photographs and insurance adjustment accounts of fires in actual buildings. Mr. Rossi says these latter simply show bad workmanship and material. The refutation of this calumny I leave to the noted architects, construction companies and tile manufacturers concerned. I am content personally to accept these buildings as complying with the usual requirements and treat the data of their fires as of interest and value in arriving at the limitations of tile fireproofing. I therefore find nothing in Mr. Rossi's letter to controvert my position that the use of unprotected hollow tile is limited to those buildings whose nature and situation preclude a severe attack of fire.

Very truly yours, H. B. Seely.

1740 Monadnock Block, Chicago, Ill., May 16, 1896.

La Rue's Formula for the Curvature of Chords.

Sir: Although disinclined to occupy space in your valuable paper by useless discussion, I feel that certain statements in Mr. Szlapka's letter, appearing in Engineering News of May 7, require some notice.

I do not mistake the point at issue. It is well known that the section α—β could as well have been taken through P_2, or any other post in the right half of the truss; the result would have been practically the same, giving the vertical shear along this section. This shear is resisted not by the post alone, but by all web members cut out by the section. Whether or not "the curvature of the top chord can easily be arranged so as to avoid any necessity for counters" has nothing whatever to do with the case. In the truss in question, the curvature of the chord is such as to require counters and, furthermore, counters will be required in all trusses in which the curvature of the chords is fixed by the proposed formula.

If Mr. Szlapka will carefully read my former letter, he will discern that I made no attempt whatever at "getting at the amount of counterstrains." Of the amount of shear on the section α—β, which Mr. Szlapka derives as stress in the post, I gave the position which, according to the usual static assumptions, is taken by the counters. I do not think that Mr. Szlapka will attempt to deny that such position of this shear is taken by the counters.

As to whether the formula for curvature really retains any practical value or has been completely annihilated by Mr. Szlapka, I leave to the decision of the engineering public. Yours very truly, Benj. F. La Rue.

Coal Exchange, Scranton, Pa., May 15, 1896.

Adulteration of Portland Cements.

Sir: I notice in your issue of May 7, letters from Mr. Hartranft and Mr. Leslie, in which they condemn the author of the Topeka bridge specifications for his attack on "American Portland cements (so called)." It cannot be said that both Giant and Saylor's, as well as a number of other Portland cements manufactured in this country are not as good as Portland cements manufactured abroad; but both gentlemen must admit that there is a large quantity of cement manufactured in the United States and sold to the general public as Portland cement, which is not Portland cement at all but simply a composition of lamp black or mortar color and natural cement, with considerable raw rock ground with it to give the cement the proper weight. The writer knows of two mills in this country that are making this kind of Portland cement, which is sold to the unsuspecting public as a genuine article. The writer can also name several parties who take two-thirds of a barrel of Portland cement and mix about one-third of a barrel of natural cement with it, which is barreled and branded as American Portland cement.

Engineers and the public generally are continually suffering from these impositions and quite naturally condemn all American Portlands.

Why don't the gentlemen referred to, as well as all other reputable Portland cement manufacturers who have so much at stake, endeavor to put a stop to this nefarious business by exposing the parties who sell this colored and adulterated cement? Every large manufacturer knows that it is on the market, as they compete with it (in price) every day.

I presume the author of the Topeka specifications has, at some time or other, gotten hold of some of this colored cement and from this standpoint condemns all American Portland cement.

Very respectfully yours.

A. D. Thompson, C. E.

Cumberland, Md., May 15, 1896.

(It may be remarked in this connection that something has been heard of adulteration of Portland cement in other countries than the United States. We hardly see, however, how the reputable and honest makers of Portland cement in this or any other country can undertake to suppress the manufacture of counterfeit imitations. As for exposing it, that is being done over and over again and will continue to be done. If there are any of the readers of this journal who, after reading Mr. Thompson's letter, still disbelieve in the necessity of requiring rigid tests of all cements, and its purchase under strict specifications, we hope they will at once sit down and write us the reasons for the faith that is in them.—Ed.)

Elastic Limit of Steel Castings.

Sir: In examining some recently published lists of steel castings, my attention was drawn to the fact that in the entire series the elastic limit was much less than one-half the ultimate strength. The greatest difference occurred with an elastic limit of 30,500 lbs. and an ultimate of 70,500, which gives an elastic limit of less than one-half the ultimate by 4,750 lbs.

Steel castings are quite frequently tested in a section 2 ins. long, and as the determination of the elastic limit with this section, by ordinary methods, is uncertain and unreliable, I have sought for data that should give some reliable information on this subject.

Through the courtesy of Mr. Fred. Baldt, Manager of the Penn Steel Casting Co., of Chester, Pa., I am enabled to furnish you with the attached report of tests.

As the elastic limits in these tests were determined on a section 8 ins. long, they are as reliable as can be had in general practice, and are comparable with the tests of rolled material.

With two exceptions, the elastic limits in these tests are less than one-half the ultimate strength, the greatest difference being 1,800 lbs.

This lowering of the elastic limit in steel castings, as compared with rolled steel, is doubtless due to the absence of any rolling or forging, and to the thorough annealing to which the castings are subjected.

From these lists it would seem that 45% of the ultimate strength was the maximum safe limit to use for elastic limits in specifications for steel castings.

Yours truly, A. C. Cunningham, C. E.,
M. Am. Soc. C. E.

51 State St., Albany, N. Y., May 16, 1896.

(The letter inclosed is as follows:—Ed.)

We give you below copies of physical tests taken from castings made by the Penn Steel Casting & Machine Co., of Chester, Pa., for the U. S. government for the gun, submarine and torpedo boats now in course of construction at the Newport News Shipbuilding & Dry Dock Co., Newport News, Va.; Columbian Iron Works & Dry Dock Co., Baltimore, Md.; Herreshoff Mfg. Co., Bristol, R. I., and Moran Bros. Co., Seattle, Wash.

These tests bars were turned to a diameter of 0.798 in., making an area of 0.500 sq. in. on a section 8 ins. long. These tests were made under the supervision of the U. S. Naval Inspectors, Past Assist. Eng. Geo. S. Willits, and Carpenter Philip Mager, stationed at the works of the Penn Steel Casting & Machine Co.:

Heat, No.	Elastic limit, lbs. pr. sq. in.	Tensile strgth, lbs. pr. sq. in.	Elongation, % in 8 ins.	Reduction, of area, %	Fracture.
749	32,900	66,300	22.61	41.7	Silky.
751	31,700	65,500	22.66	39.7	"
777	32,100	65,500	26.13	32.49	"
777	32,000	64,800	23.25	42.52	"
813	32,000	65,200	24.6	40.6	"
820	31,200	64,000	20.7	40.93	"
813	30,000	63,200	26.0	41.94	"
813	30,000	63,000	25.0	40.4	"
828	31,200	66,000	24.6	40.6	"
833	32,400	68,400	23.0	37.86	"
857	34,000	68,000	23.25	36.08	"
864	32,800	66,400	23.50	35.90	"
875	33,600	66,800	22.50	42.32	"
979	32,000	67,000	24.00	37.86	"
981	33,600	69,600	22.75	36.88	"
993	34,200	69,200	24.00	40.0	"
1,001	32,000	65,600	21.00	42.52	"
1,001	32,200	66,000	22.25	42.04	"
1,001	34,000	67,200	24.0	40.0	"
1,030	32,800	67,600	23.75	41.56	"

C. R. Hansel, Chemist.

Drop Manhole for Sewers and Subsoil Drains, Rutland, Vt.

Sir: The sewerage system at Newton, Mass., so well illustrated in Engineering News for Jan 2, 1896, has been a subject of considerable interest to me.

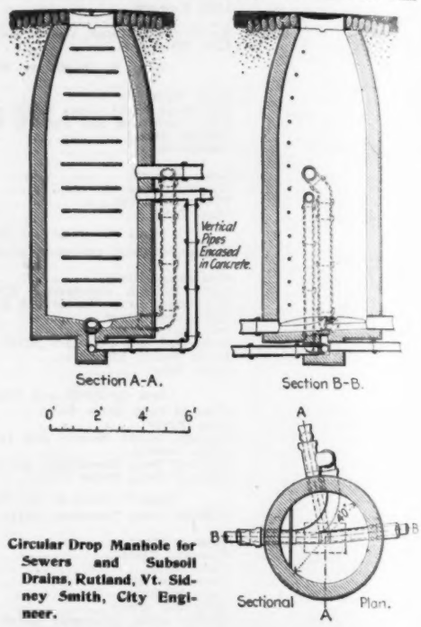
While it is very desirable to build a first-class system, such as is now possessed by the city of Newton, many of the smaller cities will not build them, on account of the large first cost, although they need sub-drainage as much as it was needed in Newton. The advantage of permanently lowering the level of the ground water has been advocated for years by sanitary engineers. It is an important sanitary measure, too often neglected.

Experience proves that better pipe joints are made where sub-drains are used. In many localities a temporary sub-drain, used for the purpose of building a sewer, is abandoned as soon as the sewer is constructed. A small additional expense to provide an outlet and to connect the temporary drains, would make a permanent sub-drain.

The cost of frequent manholes, especially if curved inverts are used to divert the flow of sewage around the inspection-hole from the sub-drains, forms quite a percentage of the cost of the small pipe line. In practice, so far as I am informed, when a sewer and sub-drain have been put in permanent order, the necessity for using the inspection-holes is very rare.

In the sewers recently constructed in Rutland, Vt., manholes have been placed at the changes of grade and direction with few intermediates. The curved inverts about the inspection-hole have been omitted and the opening between the sewer and the sub-drain sealed by a slate slab laid in cement mortar, as indicated in the enclosed plan.

The sub-drains are in such a situation that inspection is difficult. In the drop manhole, inspection of the upper sub-drain may be arranged as shown by the accompanying plan and sections. The upper sewer and sub-drain



Circular Drop Manhole for Sewers and Subsoil Drains, Rutland, Vt. Sidney Smith, City Engineer.

are continued in a straight line beyond the drop to enter the manhole in the same vertical plane, so that light may be thrown into them from the lower end or an inspection made by rods. Is this original?

The flow from the sub-drain drops vertically, while that from the sewer falls first at an angle of 45° and then vertically, just outside of the manhole, thus allowing the pipe carrying the sewage to pass by the sub-drain.

The first sewers built in Rutland on the separate system were constructed during 1895. They consist of 6 and 8-in. pipes with a 4-in. sub-drain. Sub-drains have been laid also in an extension of the combined system.

The construction of permanent sub-drains was bitterly opposed early in the season by those who are now their strongest advocates. Their usefulness became evident to the people and received favorable mention by the press, when cellars which had formerly been damp, moldy or flooded with water, became dry and have so remained.

I send you this communication to call attention to the fact that sub-drainage may be sometimes secured at slight additional cost and that some of the expensive work may be omitted without materially affecting the working of the system. Following is a record of pipe sewer construction in this city during 1895:

—Sewer.— Diam. ins.	Length. ft.	—Sub-drain.— Diam. ins.	Length. ft.
		10	150
30	2,408	8	1,490
		6	1,351
24	1,867	5	1,867
18	1,400	5	1,400
		5	498
12	2,002	4	2,002
10	252	4	200
8	4,544	4	4,544
6	7,036	4	5,398
Total.	19,509		18,900

Very truly yours, Sidney Smith, City Engineer.

Rutland, Vt., Jan. 22, 1896.

The Old Corliss Pumping Engine at Providence, R. I.

Sir: In your issue of April 2 you publish an article with illustrations of the engine built for the Hope pumping station at Providence, R. I., by Mr. Geo. H. Corliss, some

years since, that has a special interest to engineers now that the engine is about to be removed, and a few words from one who was present all through the series of trials may be acceptable.

While much that you state in the article is correct, that portion in which you infer that Mr. Corliss designed the engine for a high-duty, and was sadly disappointed in the results achieved, is open to question; and it is with the hope of doing justice to his memory that this statement is made.

It is true one might easily infer from the wording of the contract that a high duty was expected, but this contract was one of the most difficult to properly interpret that the experts in charge of the tests ever had experience with. It could be interpreted to mean almost anything, or nothing, as required, and was a cause of contention all through the trials.

In order that a proper understanding of the situation may be had, it may be said that probably there never was a political canvass in Providence in which feeling ran as high as it did during the controversy over the question of water supply at the time these engines were under test. The daily papers were full of it, and there was something behind the mere question of a pumping engine that caused the excitement. While a statement of all the facts might prove highly interesting reading, it may not be proper to refer to them at this time.

The experts engaged on this test, Messrs. Reynolds, Graff and Smith, knowing of this excited feeling on the part of the citizens and the papers of Providence, wisely concluded that everything must be done in a manner that would preclude the possibility of even an appearance of favoritism, and it was due to this fact principally that the writer was called in to take charge of the indicating.

It was while the Hope station engine was under test that the writer remarked to Mr. Corliss that the duty would be low, and received the reply that "he did not design and build that engine in expectation of getting a high duty, that twenty-five or possibly thirty million duty was all that he expected to get," but that he would build a pumping engine, in fact, had the drawings under way, at that time, that would show a better duty than anything that had been built up to that day. The result was the Pawtucket engine, the duty of which, as you truly say, was not surpassed for more than 15 years.

The acquaintance begun at this Providence trial lasted through the remainder of Mr. Corliss' life, and having his entire confidence, and having been brought in close contact with him on many occasions, the writer is well prepared to discuss this question, and knows that the Hope station engine was built for the specific purpose of keeping an even pressure on the high-service mains without the aid of any expensive reservoir, stand-pipe or like device that was supposed to be necessary at that day. That he accomplished this object is beyond question, and it seems a pity that the ingenuity displayed in the designing and building of that piece of machinery is not better known, especially by the younger men who are trying to follow in his footsteps.

In connection with this trial an incident about which nothing has appeared in print may be worth relating. As you truly say the small engine shown in the lower left hand corner worked the air pump, and the flow of water in the main was made use of to control the speed. The idea was that the slightest decrease of pressure in the delivery main should increase the speed of the main engine, also the speed of this small or air-pump engine. Up to the time of the accident about to be related, the highest speed at which the main engine had been run in actual every-day service had been 27 revolutions per minute, and from that down to one revolution in 4¼ minutes, depending on the amount of water being used, or leakages, and this change of speed was accomplished without any adjustments being made by any of the attendants. In order to meet the capacity test the speed had to go considerably above 27 revolutions per minute, and in order to get the proper speed some of the water had to be wasted. For this purpose hose were attached to hydrants near the pumping station by the fire department of the city, and a number of streams thrown, the number to be regulated as desired.

Without going into all the details it may be stated that one of the conditions was that the engine should perform in an equally satisfactory manner when drafting water equivalent to a lift of 19 ft., if memory serves rightly, but as this is written from memory principally, this figure may be wrong. However, this "lift" was to be obtained by closing down a valve in the suction pipe in plain sight of the pumping station. This "lift test," for some reason unknown to the writer, was to be made at the same time the capacity test was being made..

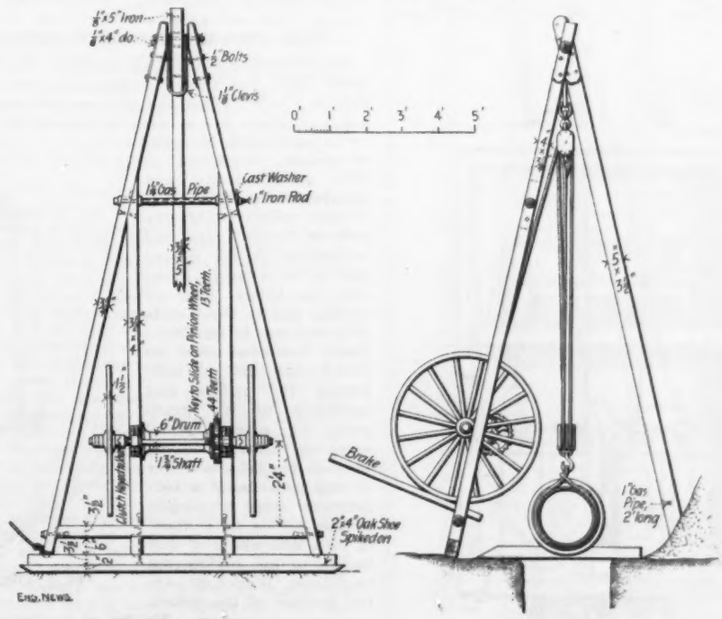
Just how it happened is a disputed question, but during the test the water was suddenly shut off from the suction pipe. Some say that a laborer who just at that moment was engaged in slowly closing down the valve in the suction main until the desired lift should be obtained, got a signal from the pumping station and closed it down tight. Others say it was anchor ice that shut off the supply, but the fact remains there was no water in the main to regulate the speed; the main engine gave a jump ahead, the air-pump engine ran out beyond the range of the governor and started off at a fearful rate. The fly-wheel, as shown by the cut, was a very heavy one. The engine-room had been so crowded with people interested in the test that it became necessary to partition off the space now occupied by the Nagle engine with a strong open fence some 5 ft. high to keep the people back. Mr. Corliss was one of the crowd outside the railing at the time the air-pump engine started on its race, and when the dust began to fly and the crowd made a break for the doors and windows to tumble out, Mr. Corliss gave a spring clear over the top of the railing, made a dive down to the air-pump engine and shut off the steam. No material damage was done, and in a very few minutes everything was working smoothly again.

At the instant this accident occurred the writer was engaged taking an indicator diagram from the suction main in the rear of the main engine and did not know what the trouble was until Mr. Corliss came around after he had shut off the steam, and in a very excited manner claimed the water had been shut off purposely to wreck the engine. He was very anxious to get the indicator diagram that had just been taken off the suction main, which showed conclusively what had caused the trouble, but as it was a part of the data of the test it could not be given to him. It was, however, in a great measure due to this incident that the writer in after years became so well acquainted with Mr. Corliss, and knowing as he does many of the facts in connection with the designing and building of this famous engine it seems but just to the memory of a departed friend that he should make the statement that said engine was not built with the expectation of getting a high duty. Undoubtedly Mr. Corliss knew at the time he was designing it that he was sacrificing all the elements that tend to make up a high duty, as well as we of the present day know it.

Yonkers, N. Y., April 28, 1896. W. H. Odell.

PORTABLE DERRICK FOR PIPELAYING.

The derrick here illustrated has been in use for years by the American Water-Works Co. and by other parties for laying pipe, hoisting material from manholes, etc. But for the exact dimensions of a derrick of this type we are indebted to Mr. W. F. McCue, of Denver, Colo., late Superintendent of Construction of the American Water-Works Co. The derrick is not patented, and as it is exceedingly useful and inexpensive, it is published here for the benefit of contractors generally. Among its other advantages, it involves less labor in handling than the ordinary tripod, and in transportation it can be moved on its own wheels by simply attaching the top of the derrick to the rear of a wagon. The drawing is so plain that no especial description of the derrick's working is necessary.



A PORTABLE DERRICK FOR LOWERING PIPE INTO TRENCHES.

DAMAGE SUITS FOR STREAM POLLUTION, at New Britain, Conn., seem to be of common occurrence. The "Herald" of that city states that there are now 14 suits pending against the city, including one begun a few days ago, and that the city paid $2,456 last year in settlement with four property owners. The "Herald" suggests that it might be well for the sewer commissioners to investigate sewage purification.

POWER BRAKES AND AUTOMATIC COUPLERS ON FREIGHT CARS.

In the published proceedings of the American Railway Association's meeting at Cincinnati in April last is a supplement to the report of the Committee on Safety Appliances which shows the present status of freight car equipment fitted with air brakes and automatic couplers. The figures given, of which we give an abstract below, form a summary of the replies received from 201 members of the association, operating 143,116 miles of road, or about 97% of the mileage represented in the association on Feb. 1, 1896. The following table shows the increase in the equipment of engines and cars with these safety appliances:

	Feb. 15, 1892.	Oct. 1, 1892.	Jan. 1, 1894.	Feb. 1, 1896.
Number of roads.....	100	149	149	201
Number cars reported.	703,825	885,751	1,013,538	1,046,769
With automatic couplers:				
No.	118,406	200,753	282,983	388,965
Per cent.....	16.8	22.6	28.0	37.1
With air-brakes: No....	88,107	144,981	236,814	305,134
Per cent.....	12.5	16.3	23.0	29.1
No. of engines reported	...	26,080	30,228	30,917
With power brakes: No.	...	20,988	25,212	27,057
Per cent.....	....	80.5	83.4	87.5

In addition to this, out of 1,042,260 cars reported, there were 1,007,918 cars (96.7%) fitted with grab-irons or hand holds, and 970,604 cars (93.1%) fitted with drawbars of the standard height. The cars not fitted with standard grab-irons or couplers of standard height include logging trucks, mine cars, four-wheel cars and company's cars. The figures for cars under construction or contract show about 17,000 to be equipped with brakes, couplers, grab-irons and drawbars of standard height and only 200 to 640 not to be so equipped. They also show 99 engines to be equipped with power brakes and seven small engines not to be so equipped. Old cars are also being fitted with brakes and couplers.

A CHEMICAL CLUB is projected in New York city. It is proposed to organize it on lines similar to those of the Engineers' Club, of New York. Among those interested in the project are the principal professors of chemistry at Columbia, Stevens Institute, the College of the City of New York, and the leading technical chemists and chemical experts residing in New York city and vicinity, also the heads of the principal firms manufacturing and dealing in chemicals. Any of our readers interested may obtain further particulars by addressing Prof. A. A. Breneмann, 97 Water St., New York city.

AN INTERNATIONAL EXHIBITION of machinery, mining appliances, metallurgical processes, etc., will be held at Brisbane, Queensland, Australia, during June, July and August, 1897.

ELECTRIC CONTROLLER FOR GRADE CROSSING ALARM SIGNALS.

In most signaling devices for giving warning of the approach of trains at highway grade crossings, the apparatus is set in operation by some sort of track instrument, but we illustrate herewith a device of this kind in which the apparatus is operated from a circuit controller placed on a telegraph pole. The controller is thus free from the shocks and vibrations to which a track instrument is subjected, and is more easily examined for repair.

The connections of the track to the controller are shown in Fig. 1. The wire A is attached to the rail B and is led through staples along the side of the tie, under the ballast, to a cable under the insulated joint C. The wire D is attached to rail E, and the wire F to rail G. These wires are all soldered to three conductors in the cable, which is laid underground from a point near the joint C and through a protecting tube into the controller box. The four rail joints C, H, J, K are insulated by wooden splice bars.

The arrangement of the batteries and circuit controller for a signal on a single-track crossing is shown in Fig. 2. The wire A (from rail B) is connected directly to the battery, while a wire loop connects the two batteries. The wire D (from rail E) goes to the binding post 4, and the wire F (from rail G) to the binding post 3. The controller is connected to the battery by the wire L, which goes to the binding post 5. The line wires M, N, leading to the alarm apparatus, are connected to the binding posts 1 and 2, thus completing the circuit from the track through the controller to the alarm and back through the controller to the track. The apparatus can, of course, be arranged for single or double-track work.

As a train passes from east to west towards the crossing, it closes the circuit between rails B and E, through the wheels and axles, and energizes the magnet O. This attracts the armature P and raises the lever Q, thus closing the circuit through the line wires to the crossing, and causing the alarm to sound. At the same time the magnet R and rail G will be cut out of circuit, and remain so until the last wheels of the train have passed off rail E. As soon as they have cleared this rail, the armature P is released, the circuit broken, and lever Q will automatically return to its normal position in 15 seconds. The controller is thus adjusted to allow ample time for trains to pass entirely off the rail G, and will then automatically reset itself in readiness to give warning of another train.

When a train has passed the crossing (going from west to east), the circuit is closed between the rails B and G by means of the wheels and axles, and the magnet R is then energized. This attracts the armature S, which raises the lever T, separating the contacts U and V, and cutting magnet O out of circuit. This prevents the raising of lever Q, and prevents the closing of the circuit of the alarm at the crossing. The controller will be reset for action in 15 seconds after the last wheels of a train going east have passed off the rail G.

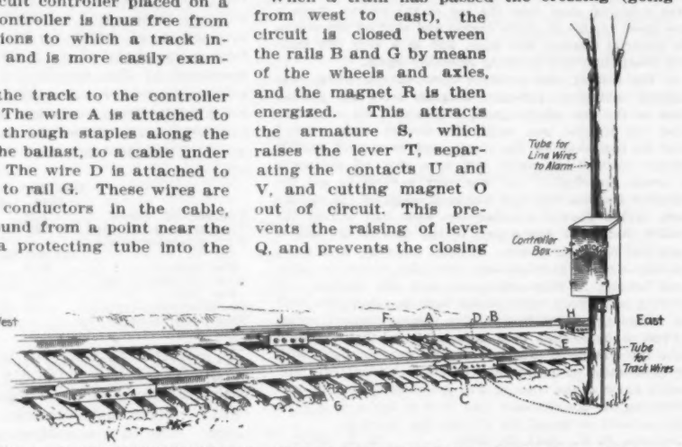


FIG. 1.—TRACK CONNECTIONS AND CIRCUIT CONTROLLER BOX FOR GONG SIGNAL AT HIGHWAY GRADE CROSSING.

This device is being introduced by the American Signal Co., of Baltimore, Md., and is considered superior to the mercury-contact track instrument heretofore used by the company, which was illustrated in our issue of June 28, 1894. In that issue we also illustrated and described the apparatus for operating the gong signal at the crossing, and the same apparatus is used with the circuit-controller system.

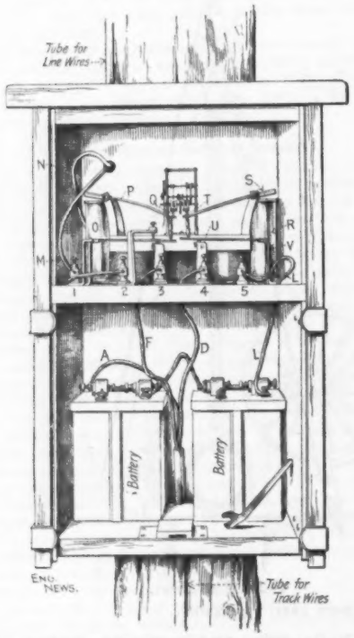


Fig. 2.—Battery and Controller for Crossing Signal (Single Track).

NOTES FROM THE ENGINEERING SCHOOLS.

The Worcester Polytechnic Institute, Worcester, Mass.—The 26th annual catalogue of the Institute is a well printed pamphlet of 158 pages, 63 pages of which are devoted to lists of the graduates, arranged in order of classes, beginning in 1871, alphabetically and geographically. The first of these lists contains the present location and the occupation of the graduates, as far as known. Probably no better way of making known the results of a training in the Worcester Institute could be found than that of publishing the names and addresses of its graduates of several years' standing. On glancing through the list the writer of this note found a surprisingly large proportion of the names to be those of men who are now well known in the engineering profession. If such men are the product of the school, it must be a good one. The list of graduates now numbers 680; the graduating classes of the last two years each numbered 47. The courses of study offered by the Institute are five in number, viz: 1. Mechanical Engineering; 2. Civil Engineering; 3. Chemistry; 4. General Scientific; 5. Electrical Engineering. The course in mechanical engineering includes probably more shop-work than in most of the other schools of the country. The Washburn shops comprise an actual machine and woodworking plant, turning out commercial work ready for sale, and conducted by commercial methods, but always subordinated to the idea of instruction, so that it is not a profit making concern, but, on the contrary, makes a large loss every year. The equipment of the Institute has recently been greatly enlarged, and large new buildings for an engineering and a power laboratory are now nearing completion.

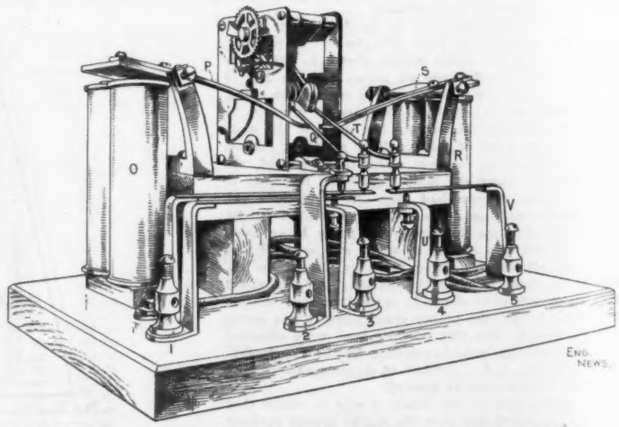


FIG. 3.—CIRCUIT CONTROLLER FOR CROSSING SIGNAL (SINGLE TRACK).

The Rose Polytechnic Institute, Terre Haute, Ind.; 14th Annual Catalogue; pp. 72.—The Rose Polytechnic Institute was opened in 1883. It was largely modeled after the Worcester Polytechnic Institute, especially in making shop-work an important feature in its engineering course, and in its earlier years the students were expected to make articles for the market. This idea of making the shop a sort of commercial machine shop seems to have been dropped, if we read the present catalogue aright, and the shop is now managed solely for the advantage of the students. The students in mechanical engineering spend on the average 15 hours per week in practice during the first year and 10 hours per week during the remaining three years. During this time they receive instruction from skilled workmen in the various departments. The workshop is a two-story brick structure, 40×160 ft., with a foundry 36×100 ft. The graduates of the eleven classes, since 1885, now number about 160, of whom 19 were in the class of 1895. There are four parallel courses in the Institute, viz.: Mechanical, Civil and Electrical Engineering and Chemistry. The courses are distinct after the first two terms of the freshman year. There are no special or partial courses. The entrance requirements have been advanced from year to year, and the Institute now ranks in the scope and extent of the instruction given with the best engineering colleges in the country.

The New York University sends us three small pamphlets entitled "University School of Engineering," "Laboratory of Chemistry, Hand-book for 1895-6," "School of Civil Engineering," and some new Plans and Constructions. The first of these is a brief circular, giving information concerning the courses in civil engineering and chemistry; the second contains a number of half-tone illustrations of the new site of the University, including some views of scenery on the Harlem River, taken from the buildings. The third shows the ground plan and elevation of the new University building. The New York University has recently made a most important move in obtaining a new site for its college and for its School of Engineering, north of the Harlem River, between Morris Heights and Fordham Heights. The new site is easily reached by the New York Central R. R., to Morris Heights station, or by the Manhattan Elevated Ry., to Morris Heights or Fordham Heights station. On the old site, on University Place, fronting Washington Square, a fine ten-story building has been erected, which is used by the Schools of Law and Pedagogy. The administrative offices are also at present located here. On the new site the Hall of Language, the Havemeyer Laboratory and a dormitory, known as the Charles Butler hall have been completed. The library, administration, auditorium and museum building, a monumental structure, is now under construction.

TESTS OF THE TIGHTNESS OF A VITRIFIED EARTHENWARE WATER CONDUIT.*

By Dabney H. Maury, Jr., Superintendent Peoria Water Co., Peoria, Ill.

During the past summer, in consequence of droughts of unprecedented severity and duration, it became necessary for the Peoria Water Co. to increase its water supply, in order to meet the rapidly growing demands of its consumers.

After a careful survey, by means of test-wells, of the water-bearing gravel underlying the territory adjacent to the company's property, it was decided to supplement the supply in the main well by sinking another open well in the gravel, 3,340 ft. north of the main well. The supply was later still further increased by sinking three 6-in. tubular wells between the two open wells and distant respectively 1,050, 1,800 and 2,500 ft. from the main well. A line of vitrified, salt glazed pipe, 24-ins. in diameter, was laid, connecting all the new wells with the old one. The water from the new wells is raised by a new system, patents on which have been applied for by the writer, to the level of the earthenware conduit, discharged into it, and then allowed to flow by gravity into the main well, whence it is drawn by the company's high duty pumps and forced into the mains. The object of this paper is to describe, briefly, the construction of the conduit, and more particularly, to give an account of the tests made to determine the amount of its leakage under pressure.

The conduit was laid on an uniform grade of 0.05%. At suitable intervals, generally about 300 ft., manholes were built to allow easy access to the conduit for inspection and repairs. Masonry vaults, built around the tubular wells, were carried up above high water mark of the Illinois River, and these, as well as the new open well, were protected against damage from floods and ice. As the conduit was designed to supply additional water, it

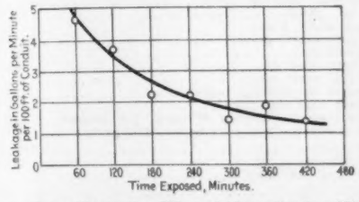


Fig. 1.—Curve Illustrating Effect of Absorption in a Vitrified Earthenware Water Conduit.

was important that there should be as little leakage as possible, and it was also considered desirable that infiltration from the outside should be prevented. It was therefore necessary to make the conduit as nearly watertight as possible, and no pains were spared to accomplish that end.

The pipe used was double strength, vitrified salt-glazed sewer pipe, and was made by the Monmouth Mining & Manufacturing Co. The pipes were subjected to an unusually rigid inspection, a large portion of the pipes that were rejected as unsuitable for use in the conduit being afterwards readily sold, by reason of their good quality, for 96% of their cost price. The weight of pipe was about 345 lbs. for each length of 2 ft. ⅛ in. The depth of bell was 2 3-16 ins. for the first 2,400 ft. and 2½ ins. for the remainder of the distance. The width of joint space was 11-10 in. at outer end of bell and about 5-16 in. near the inner end. Owing to the fear that pipe of so large diameter might be cracked in the deeper part of the trench, instructions were given to the foremen to be unusually careful in back-filling. These instructions were in one instance disregarded and as a result about 90 ft. of pipe had to be replaced. The pipe in every case were found cracked along the crown and bottom, the cracks being continuous across the joints as though there were one continuous pipe. The distortion from circular to elliptic form was quite noticeable from the inside of the conduit, the pipe being flattened from the undue pressure thrown on the crown before the sides and quarters had been sufficiently tamped and settled. These cracks were in no case the fault of the pipe, which was of uniformly excellent quality; 31 ft. of the cracked pipe were replaced by a 2-ft. brick conduit, and the remainder by pipe.

In laying the pipe, the joints were made with Portland cement mortar, both German and English cements being used with a mixture of 1 of cement to 1 of sand. The joints were pointed from the inside, and afterwards brushed with cream of neat Portland cement. A prize was offered to the pipe-layer whose work should, after the completion of the conduit, show the best results, and competition was stimulated in every way possible.

As the writer was unable to learn of any test, made prior to the beginning of this work, to determine the leakage of earthenware pipe lines under pressure, a preliminary trial was made to see whether it was possible to secure, under actual working conditions, reasonably tight joints. Three lengths of 24 ins. pipe were laid in a shallow open trench so that they were entirely accessible for inspection from all sides. One end of the pipe was closed by a brick wall; in the other was fitted a 24 × 18 ins. reducer; then an 18 ins. 45° bend turning up; next another 18 ins. × 45° bend, also turning up; and finally an 18 ins. riser 24 ins. long. All joints were carefully made in the ordinary manner with Portland cement mortar, mixed 1 to 1, and after the cement had set about 15 hours, the pipe was filled with water to the top of the riser. This gave a little over 4 ft. head above the bottom of the pipe. The joints of the 45° bends cracked slightly, due to the overhung and imperfectly supported weight of bends, riser and water column. The other joints, however, remained so tight that on the whole the result was considered encouraging.

The next test was made on the first 100 ft. of pipe permanently laid in the trench. The trench here was from 29.2 to 27 ft. in depth to grade. An 8-in. brick division wall, 5 ft. high above grade, was built across manhole 100, and the end of the pipe where it discharges into the main well was closed by bolting a cast-iron blank flange to the length of cast-iron pipe in which the conduit terminated. On shutting off the supply of water, the water in the manhole fell rapidly until in 12 minutes it was as low as the top of the pipe line. The loss in 12 minutes was 144 gallons. The pipe was drained and inspected, and six or seven bad joints were found and repaired by pointing and afterwards brushing with cream of neat Portland cement.

In the accompanying table is a compilation of 108 tests, the one just described being numbered 1 in the table. The table contained the results of every test made, although it has been much condensed. In some cases, where observations were taken at intervals of one minute for a considerable period, the readings at intervals of 15 minutes alone appear in the tables; in others, observations taken every 15 minutes are tabulated only as to hourly intervals.

The tests were usually made in the same manner as test No. 1, just described, by separating the conduit into sections by means of division walls in the vaults or manholes, filling the sections with water, and noting, at stated intervals, the level of the water surface. The head was taken in each observation, as the height of the surface of water above the grade line, or the bottom of inside of conduit, at the center of the length of the portion tested. The equivalent average pressures in pounds per square inch, were obtained by dividing the average head, by the constant 2.31. The apparent total leakages were sometimes determined by calculating from actual measurements the contents in gallons of the portions of the manholes or vaults emptied during the test; sometimes by re-filling the pipe from a vessel of known capacity, and sometimes by both methods, one used as a check on the other. The average number of square feet of masonry surface exposed to leakage during each test was calculated separately for each average head and from actual measurements of the inner surfaces of vaults, manholes, walls, etc., of each section of the conduit tested.

In examining the figures of the table these facts are noticeable:

(1) In a given series of tests of any part of the conduit as, for instance, in tests Nos. 2 to 8, of the portion of the conduit from 0 to 100, in tests Nos. 23 to 27, of from 0 to 1,800, and in tests Nos. 31 to 35, of the same portion, the leakage appears to diminish much more rapidly than would be due to the diminution of pressure.

(2) In any series of tests in which the pressure is kept practically constant for some length of time, as in tests Nos. 36 to 42, from 0 to 1,800, the leakage appears to diminish as the duration of the test increases. As the water was exceedingly clear and contained in suspension no solids to clog the pores of the mortar and masonry, it is evident that this apparent diminution of leakage is due to the absorption by the bricks, mortar and pipes, of a large amount of the water which is charged in the table to "leakage." The effect of this absorption on the apparent leakage is clearly shown by tests Nos. 36 to 42, from the results of which the curve in Fig. 1 has been drawn.

It may be assumed as a fact that the vitrified salt-glazed pipe absorbed, in proportion to the surface exposed, less water than the brick masonry of the vaults and manholes. The tests also show that the leakage through the masonry was much greater per square foot than that through the pipe, notwithstanding the fact that the latter, being lower, was subjected to greater pressures. This can be more clearly seen by comparing the apparent leakage in gallons per minute per 100 ft., in tests Nos. 81, 82 and 83, with tests Nos. 86, 87, 88, 89 and 90. The first case shows from 62.8 to 53.5 sq. ft. of masonry exposed to leakage per 100 ft. of conduit tested, the last shows only from 4.6 to 3.1 sq. ft. of masonry exposed to leakage per 100 ft. of conduit tested. The apparent rate of leakage per 100 ft. of conduit tested in the former series of tests is from 8 to 14 times greater than in the latter. A comparison of any other two series of tests will give somewhat similar results.

For instance, Fig. 1 shows the apparent leakage of the portion of the conduit from 0 to 1,800 to be 0.463 gallons per minute per 100 ft. during the first hour, while the apparent leakage, during the seventh hour was at the rate of only 0.139 gallons per minute per 100 ft.—less than one-third as much as was still diminishing. But even this latter figure is larger than the actual leakage attributable to the conduit proper, for there were in these tests 580.3 sq. ft. of masonry exposed to a leakage under pressure, or 32.2 sq. ft. per 100 ft. of length of conduit tested; and it seems reasonably cer-

Table Showing Results of Tests of Vitrified Earthenware Water Conduit to Determine Amount of Leakage.

No. of Test.	Duration of test, mins.	Lin. ft. of pipe tested.	Masonry exposed to leakage per 100 ft., sq. ft.	Av. head above grade line, ft.	Pres. lbs. per sq. in.	Leakage, gals. per min. per 100 ft.
1	12	100	19.4	3.31	1.43	12.00
2	4	100	32 6	4.58	1.99	0.94
3	4	100	31.6	4.50	1.95	0.94
4	61	100	25.5	3.88	1.68	0.51
5	75	100	22.0	3.55	1.54	0.31
6	810	100	23.0	3.65	1.58	0.11
7	90	100	12.8	2.96	1.15	0.03
8	200	100	11.5	2.50	1.08	0.04
9	110	100	31.5	4.47	1.94	0.13
10	100	100	28.6	4.19	1.81	0.19
11	300	100	31.3	4.45	1.93	0.05
12	60	100	25.9	3.98	1.72	0.148
13	60	100	30.3	4.80	2.10	0.035
14	60	100	35.6	4.79	2.08	0.032
15	15	1,800	31.8	4.56	1.97	0.5
16	15	1,800	30.9	4.50	1.95	0.167
17	15	1,800	30.6	4.45	1.93	0.389
18	15	1,800	30.2	4.39	1.90	0.278
19	14	1,800	33.0	4.74	2.05	0.358
20	15	1,800	32.6	4.69	2.03	0.278
21	30	1,800	32.2	4.62	2.00	0.222
22	60	1,800	32.8	4.71	2.04	0.208
23	15	1,800	32.8	4.71	2.04	0.278
24	15	1,800	32.0	4.67	2.02	0.167
25	15	1,800	32.3	4.64	2.01	0.167
26	15	1,800	32.1	4.60	1.99	0.222
27	780	1,800	28.7	4.07	1.76	0.11
28	15	1,800	31.4	4.50	1.95	0.172
29	60	1,800	31.0	4.43	1.91	0.144
30	45	1,800	30.5	4.35	1.88	0.095
31	30	1,800	33.0	4.74	2.05	0.158
32	30	1,800	32.6	4.68	2.03	0.158
33	30	1,800	32.3	4.63	2.00	0.131
34	60	1,800	31.8	4.56	1.97	0.126
35	30	1,800	31.4	4.50	1.95	0.094
36	60	1,800	32.2	4.62	2.00	0.463
37	60	1,800	32.2	4.62	2.00	0.37
38	60	1,800	32.2	4.62	2.00	0.23
39	25	1,800	32.2	4.62	2.00	0.222
40	30	1,800	32.2	4.62	2.00	0.139
41	15	1,800	32.2	4.62	2.00	0.185
42	20	1,800	32.2	4.62	2.00	0.139
43	76	3,300	30.1	4.32	1.87	0.281
44	45	3,300	28.1	4.03	1.75	0.174
45	30	3,300	27.9	3.98	1.72	0.129
46	30	3,300	28.0	4.00	1.73	0.169
47	801	3,300	24.2	3.54	1.54	0.11
48	60	3,300	29.6	4.23	1.83	0.233
49	60	3,300	28.9	4.10	1.75	0.17
50	60	3,300	27.9	3.99	1.72	0.17
51	60	3,300	27.2	3.88	1.68	0.156
52	215	3,300	25.9	3.68	1.59	0.134
53	60	300	86.8	4.78	2.07	0.152
54	60	300	85.0	4.53	1.96	0.108
55	60	300	83.4	4.31	1.87	0.103
56	60	300	82.5	4.13	1.79	0.084
57	480	300	78.7	3.62	1.56	0.58
58	540	300	73.3	2.89	1.25	0.032
59	15	412	12.9	4.39	1.90	0.59
60	15	412	11.4	4.00	1.73	0.42
61	30	412	8.5	3.56	1.55	0.313
62	40	412	7.0	3.06	1.32	0.253
63	40	412	4.4	2.63	1.14	0.155
64	60	412	13.3	4.60	1.99	0.10
65	60	412	10.7	4.28	1.85	0.084
66	60	412	10.8	4.03	1.75	0.065
67	60	412	9.8	3.80	1.65	0.050
68	480	412	7.8	3.36	1.45	0.035
69	540	412	4.2	2.57	1.11	0.018
70	5	134	10.5	4.60	1.99	0.581
71	5	134	10.3	4.56	1.97	0.347
72	900	134	8.6	4.27	1.85	0.021
73	60	238	6.4	4.54	1.96	0.283
74	60	238	6.0	4.05	1.76	0.119
75	60	238	4.6	3.82	1.61	0.080
76	60	238	4.2	3.67	1.59	0.042
77	480	238	3.6	3.42	1.48	0.023
78	540	238	2.3	3.08	1.33	0.014
79	75	200	67.2	4.75	2.06	0.385
80	60	200	64.8	4.60	1.99	0.333
81	60	200	62.8	4.47	1.94	0.333
82	480	200	58.9	4.22	1.83	0.218
83	540	200	53.5	3.87	1.68	0.149
84	15	750	15.4	4.58	1.98	0.166
85	15	750	15.2	4.55	1.97	0.166
86	60	550	4.6	4.29	1.86	0.043
87	60	550	4.3	4.09	1.77	0.023
88	60	550	4.2	4.00	1.74	0.012
89	495	550	3.8	3.77	1.63	0.01
90	545	550	3.1	3.34	1.45	0.009
91	60	466	30.0	4.37	1.89	0.804
92	60	700	16.4	4.53	1.96	0.275
93	60	700	15.4	4.30	1.86	0.23
94	60	700	14.5	4.11	1.78	0.184
95	60	700	13.9	3.97	1.92	0.138
96	500	700	12.1	3.59	1.56	0.083
97	545	709	9.9	3.11	1.35	0.046
98	60	1,500	28.7	3.91	1.69	0.795
99	300	1,500	28.3	3.87	1.67	0.531
100	30	1,500	28.6	3.90	1.69	0.407
101	942	1,500	22.0	3.19	1.38	0.182
102	60	784	15.4	4.04	1.75	1.171
103	60	800	53.4	.25	1.88	0.751
104	60	800	51	.16	1.80	0.601
105	60	800	49.5	4.00	1.74	0.563
106	60	800	47.4	3.81	1.65	.488
107	509	800	42.8	3.40	1.47	0.261
108	545	800	37.5	2.93	1.27	0.198

Note.—Diameter of pipe 24 ins.; thickness, 2 ins.; length of each pipe, 2 ft. ⅛ in.; depth of bell, 2 3-16 ins., for first 2,400 ft. and 2½ ins. for remaining 700 ft.; joint space, 5-16 in. at inner end of bell and 11-16 in. at outer end.

*Abstracted from a paper read at the annual convention of the Illinois Society of Engineers and Surveyors, Jan. 28 to 31.

tain that this masonry was responsible for a large proportion of the small amount of leakage noted. The necessity of having to put the conduit into continuous service as soon as the well and pumping plant were completed sufficiently to supply water, prevented further tests for leakage and absorption, inspections of the inside of the conduit, and repairs to those portions of the conduit which might seem to require them. The whole line was severely tested, however, by the December rains. Towards the close of December, the end of the conduit leading into the main well being open, the ground-water rose very rapidly on the outside of conduit to a level 9 ft. above grade. The stream of water flowing into the well was remarkably small, and while there was no means of measuring it accurately at the time, it seemed but little, if any, in excess of the amount of water which could be seen to flow from the partly-closed driven wells.

With the ever-growing importance of economy of water used in flushing sewers, especially in the separate system, these tests would seem to indicate the advisability of seriously considering the introduction of clauses in specifications for sewer work, looking to tests of the sewers under pressure before acceptance, and the fixing of a maximum allowable amount of leakage. On the other hand, the knowledge of the fact that an earthenware pipe line can be made practically water tight, might well lead to the introduction of such conduits in situations were the use of cast-iron pipes only had hitherto been contemplated.

From the results of all the tests the writer feels assured that if the conduit were discharging into the well at its lower end, and there were any given head, up to, say, 6 ft. of water above grade at its upper end, the total leakage in 24 hours of the conduit over its entire length would not exceed from 1-50 to 1-25 of 1% of the discharge of the conduit under the given head.

A GEARED LOCOMOTIVE FOR CONTRACTORS' USE.

The contractors' locomotive is a very important item of the plant for many engineering works, quarries, brick yards, etc., and while fineness of finish and economy in operation are not important requirements, strength of parts and attachments is exceedingly important to enable the engine to work regularly over a very rough track and to withstand the shocks and rough handling to which it is inevitably subjected. In a majority of cases the engines used by contractors are ordinary locomotives of small size, with piston rod connected directly to the driving wheels by a connecting rod, but in recent years geared locomotives have shown such advantages as to come into favor. We show herewith a geared locomotive designed for contractors' use, and built by the John F. Byers Machine Co., of Ravenna, O.

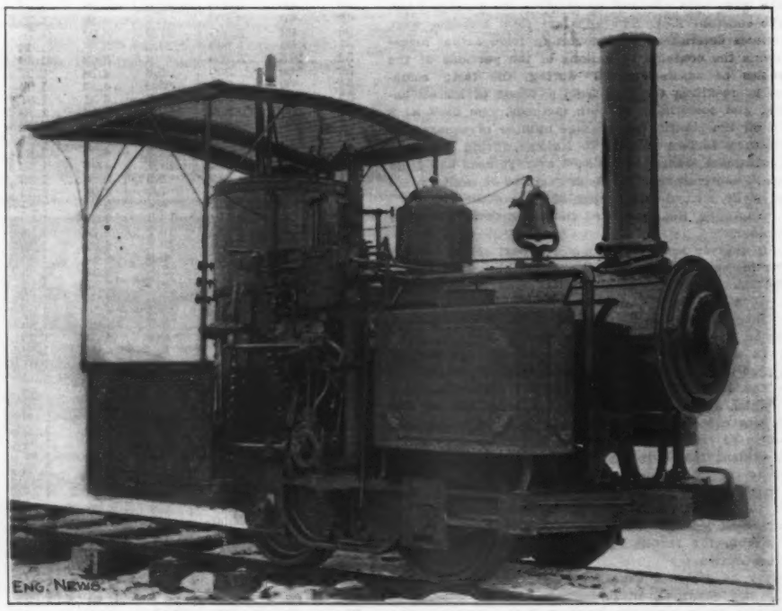


FIG. 1.—GEARED LOCOMOTIVE FOR CONTRACTORS' USE.
John F. Byers Machine Co., Builders.

This locomotive is a four-wheel tank engine, and has heavy cast-iron sectional frames, in which are formed the guides for the axle boxes, and which serve to add to the adhesion weight of the engine. The wheels are 24 ins. in diameter, and are placed inside the frame for a track of 36 ins. gage, and outside for standard gage. They are of cast iron, with chilled treads. Upon the middle of each side frame is mounted a vertical inverted engine, driving a main shaft, which carries a driving pinion, A. This pinion drives two gear wheels B, B, on countershafts, which in turn drive the two pinions C, C, on the axles of the carrying wheels. It is plain spur gearing, back geared 3 to 1, three revolutions of the engine giving one revolution to the axles. The gear wheels are cast with solid webs and wide faces, and the pitch of the teeth is 1½ ins. The countershafts are 2 7-16 ins. diameter, carried in bearings on a transverse frame or bedplate, which is bolted to the side frames. The main axles are of steel, 2 15-16 ins. diameter, with large bearings carried in oil boxes. The leading axle has side-bearing bars D, D, which rest on bearing boxes on the axle E, E, and these bars carry the transverse equalizer F. This arrangement allows sufficient vertical play in the leading main bearings, and also effects such a distribution of the weight that the engine will ride steadily over any ordinary inequalities in the track, and will pass easily around curves of 25 and 30 ft. radius.

The boiler is of T shape, with a circular firebox in the vertical leg and tubes in the horizontal barrel. This barrel is entirely filled with water, the water level reaching up into the vertical leg, and steam is taken from the upper part of this leg, which serves as the steam dome. The shell is lagged and jacketed in the usual way. The exhaust pipes run full size to the exhaust nozzle in the smokebox, and discharge into a petticoat pipe of the usual pattern. The vertical extension of the exhaust pipes downward on the outside of the smokebox, as shown in the general view, is for the purpose of a drip, and the lower end of each extension is provided with an opening ⅛ in. diameter, which is left permanently open. In the later engines the exhaust is run from the cylinders directly underneath the boiler, and thence by a single pipe to the smokebox, a single drip pipe with permanent opening being provided. The sandbox and bell are mounted on the boiler barrel, and the fittings include a glass water gage, water try cocks, two injectors, etc.

The engine is provided with a friction brake, shown in the side elevation, which is placed on the rear countershaft. It consists of two cup-shaped disks G, G, faced with wooden friction blocks H, H. These disks are attached to two yokes J, J, which in turn are moved in line with the countershaft by means of the threads on the operating shaft K. The brake is applied by moving the disks G, G against the center disk L, which is keyed to the countershaft. The yokes J, J and disks G, G work loose on the shaft, but are fastened at the lower or forward end of the yokes J, J to the transverse bedplate. This brake is operated by a horizontal hand wheel M, and bevel gear N. It is powerful and sensitive and very easily handled.

The drawings show only the iron frames, the wooden footboard and front end supports being omitted. The front and back cross frames have been changed somewhat from the form shown in the photograph, but the arrangement of the engines, main shaft, countershafts, gears, driving wheels, etc., is the same in all the machines. These locomotives are said to give a steady drawbar pull, and to be capable of hauling a train load of 250 tons (including weight of cars) at a speed of six to eight miles per hour on a straight and level track. Their short wheelbase enables them to pass the very sharp curves usually to be found on contractors' track and industrial railways. Four of these locomotives have been built thus far, and three of them are in service, being used by the Casparis Stone Co., of Logansport, Ind.; the Buffalo Cement Co., of Buffalo, N. Y., and W. J. Murray, contractor, of New York city. The general dimensions of the engines are given in the accompanying table:

Contractors' Geared Locomotive.

Driving wheels, diam.	24 ins.
Journals, driving axles	2 5-16 × 4 ins.
Axles, diam.	2 15-16 ins.
Main shaft, diam.	2⅝ ins.
Countershaft, diam.	2 7-16 ins.
Wheelbase	3 ft. 4 ins.
Length over all	12 ft. 2 ins.
Width over all	6 ft.
Weight in working order	11,000 lbs.
Full coal capacity	250 lbs.
Full water capacity of tank, 100 gallons	834 lbs.
Allowed for water in boiler, 180 gallons	1,500 lbs.
Cylinders	5½ × 7 ins.
Distance c. to c.	4 ft. 1 in.
Piston rod, diam.	1 in.
Valve Gear	Link motion
Steam ports	9-16 × 4½ ins.
Exhaust ports	1 × 4½ ins.
Lap of valves	5-16 in.
Lead of valves	1-16 in.
Max. travel of valves	2 ins.
Boiler; type	Tee
Vertical leg	32 × 60 ins.
Barrel	26 × 64 ins.
Tube sheet and barrel plates	¼ in.
Height from rail to center line	3 ft. 9 ins.
Length of smokebox	1 ft. 8 ins.
Working steam pressure	120 lbs.
Firebox	Circular
Diameter inside	28 ins.
Depth inside	26 ins.
Side plates	5-16 in.
Crown sheet	⅜ in.
Grate area	4 sq. ft.
Staybolts, diameter	¾ in.
Water space, width	2 ins.
Tubes; material	Steel
Number	32
Diameter, outside	2 ins.
Length between tube plates	6 ft. 0 ins.
Heating surface	
Tubes	88 sq. ft.
Firebox	14 sq. ft.
Total, with exterior tube area	102 sq. ft.
Exhaust nozzle, diam.	1 11-16 ins.
Smokestack, smallest diam.	8 ins.
Height	3 ft. 4 ins.
Height from rail to top	8 ft. 2 ins.
Tank capacity	100 gallons
Coal capacity	250 lbs.
Brake	Friction disk, operated by hand.
Gearing:	
Driving pinion; diam., 5 13-16 ins.; number of teeth	12
Intermediate pinion; diam., 12 ins.; number of teeth	25
Axle gear wheel; diam., 17 9-32 ins.; number of teeth	36

THE COMPRESSIVE STRENGTH OF CAST-IRON PIPES 6 FT. IN DIAMETER.*

In making the Petrie St. bridge improvement, the city of Cleveland constructed a large fill 60 to 70 ft. in height across the valley, and a plate-girder crossing over the railway tracks. The brook in the bottom of the valley had to be taken care of by a culvert. It was during the winter, and at a time when the Chamber of Commerce was passing the usual resolutions about helping the poor, and the cry was to afford work to unemployed men.

We made two designs, one for a stone culvert and one for a cast-iron culvert 6 ft. diameter. The argument was used that in winter it was difficult to get stone, and this meant delay; and the city wanted to adopt methods which would put the greatest number of men to work immedi-

*Taken from a paper on "Experiences in an Engineer's Practice," by Mr. Walter P. Rice, read before the Civil Engineers' Club of Cleveland, Feb. 11, 1896, and printed in the March number of the "Journal of the Association of Engineering Societies."

ately. It was finally decided to go ahead with the cast-iron culvert. The pipe was 6 ft. diameter and about 2 ins. thick, cast by the Variety Iron Works Co., of Cleveland. I am not sure whether it was in 6-ft. or 8-ft. lengths, but I think it was in 8-ft. lengths. When we came to investigate the question of proper thickness for this pipe, we could find no information in regard to the use of pipe of that diameter, and were at a loss to form a correct estimate of the proper thickness. We took what we thought to be an extreme precaution and considered pressure in certain directions on the assumption of hydraulic pressure. After estimating the pressure, we found plenty of formulas with regard to internal pressure, but could find nothing satisfactory as regards resistance to external pressure. We used the best information at hand, in the shape of a German formula, and concluded that a thickness of 1½ ins. was ample. We added what might be called a factor of ignorance, and made it 1⅝ ins.; and the manufacturer added another factor to increase the amount of his bill, and it was cast almost 2 ins. thick.

The foundation under the entire fill was very good. We struck one bad place at the edge of the fill, where the soil was soft. I left directions to take out all the soft material and refill with wet sand, tamped in layers until sub-grade was reached, and then to put concrete on top of that. This I supposed was done, although I was not there at the time. After the foundation had been prepared, a bed of Portland cement concrete, 9 ft. wide and 18 ins. thick was laid, the pipe put in place, and the concrete carried up to the spring line, where it was 9 ins. thick on each side of the pipe. From this point the concrete was finished tangent to the circumference. Orders were given to have the fill deposited in layers and tamped for a width of not less than 25 ft. over the culvert, and I have no reason to suppose that it was badly done. Some time after the fill was constructed, in making an examination of the interior of the culvert, which is several hundred feet long, I found four lengths of pipe all adjacent or contiguous, cracked longitudinally top and bottom. For instance, there was a longitudinal crack on the top and bottom, running the entire length of four sections. Upon taking measurements, I found that there was a difference of 4 ins. between the horizontal and vertical diameter of the pipe. We put in temporary bracing until the fill got through settling. The entire fill was made with more than usual care, and as the settlement was not at all excessive, I cannot account for the failure of these four lengths. If they had not been adjacent to one another I might have thought that it was due to flaws or initial strains in the material; but the pipes were contiguous. The material was first class and subjected to the usual transverse tests. I can only make this one supposition: The fractured pipes were in the neighborhood of where we found the pocket of soft material. The inspector claimed to have had all of same removed, and there was at least 3 ft. of fine sand and 18 ins. of Portland cement concrete under the pipes at this point and the material over the culvert was tamped before the fill was made. The law of transmission of pressure in a fill of this sort and the law of resistance of the cast-iron ring under such conditions have always been interesting questions to me. What is the law of pressure? What is the law of resistance under these conditions?

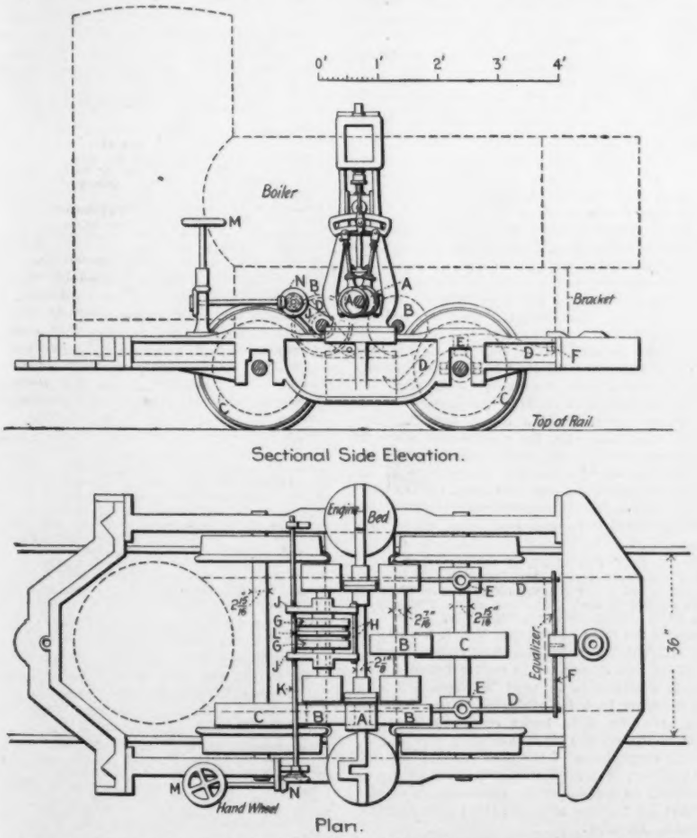


FIG. 2.—PLAN AND SIDE ELEVATION OF MACHINERY OF GEARED LOCOMOTIVE.

GAS MOTORS FOR WATER-WORKS.

Gas motors for pumping water are finding favor in Germany, according to "Kuhlow's German Trade Review," and at a late congress of German engineers, at Cologne, Mr. Mansel presented some statistics on this head. Among the primary advantages claimed for gas motors are economy of space, as compared with steam engines, and a great saving in the production of motive power. By the use of petroleum water can be pumped in places where steam or hydraulic motors can not be employed and gas works do not exist. The use of gas-motors also adapts itself advantageously to the working methods of a gas plant, as this motive power can be utilized during the day time when there is little or no demand for the gas as an illuminant.

Germany was the first country to adopt gas as a motive power in pumping water. Gas-motors, for this purpose, were installed at Duereu and Quedlinburg in 1884; at Coblenz and Rothwell in 1886; at Fuerth and Peine in 1887, and at Muenster and Carlsruhe in 1888. In some of these plants the gas-motors are used with steam engines to supply any emergency demand. The following table shows the results obtained by gas-motors in different water-works, these works being arranged according to date of erection:

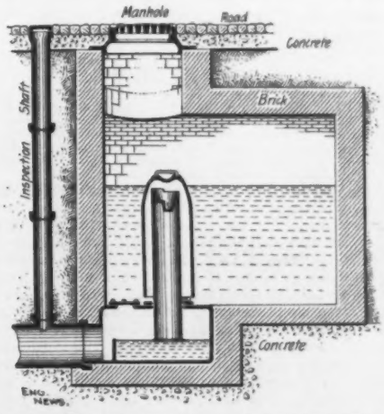
The last two plants show a material improvement in the utilization of gas. The motors used at Muenster have an efficiency of 912,950 ft.-lbs. per lb. of fuel used. As an average there was used at this plant, in 10 hours, 170 lbs. of coke and 400 lbs. of anthracite coal for producing gas. A steam engine would have consumed three times this amount of fuel for the same work. At Rothenburg, where the motors are run with gasoline, the efficiency is 1,603,750 ft.-lbs. per lb. of gasoline. At Hohenstein, petroleum motors give an efficiency of 1,724,000 ft.-lbs. per lb. of petroleum.

Cities.	No. of motors.	H.P.	Ft. lbs. produced per cu. ft. of gas used.
Duereu	2	40	46,565
Quedlinburg	2	15	49,258
Coblenz	3	40	54,071
Fuerth	2	40	54,071
Carlsruhe	2	50	53,047
Kettwig	1	15	47,313
Einbeck	2	10	48,234
Bingen	2	12	52,228
Goettingen	1	10	52,676
Meissen	2	50	70,400
Constanz	1	10	71,276

ENGLISH SEWER FLUSHING PRACTICE.

An exhaustive inquiry regarding the sewer flushing arrangements of towns in the United Kingdom was made a few months ago by Mr. Thos. H. Nesbitt, Clerk to the Douglas Town Commissioners. The information obtained was compiled by Mr. Nesbitt mostly in tabulated form, and has been reprinted as a 20-page supplement to the London "Contract Journal." The information relates to 224 towns, ranging in size from 2,000 to about 500,000 inhabitants. Some of the points likely to be of interest to American engineers have been abstracted as follows:

Nearly all the towns in the list employ flushing of some kind, whether it be by turning in water from a stream, connecting with water mains, backing up sewage in the conduit and releasing it, or by means of vans or flush tanks, automatic or otherwise. About a third of the municipalities in question report some form of patent automatic siphon in use in connection with flushing tanks, although in a large number of instances only from one to three such devices are in use. The use of sewage for flushing purposes is rare, even where the manholes are used for flushing, the custom seeming to be to impound fresh water rather than sewage upon plugging sewers at the manholes.



Rogers Field's Self-Acting Sewer Flushing Chamber.

Where fresh water for flushing is taken from the water supply mains the practice as to charges for the same vary largely. If the water-works are owned by the municipality no charges are made in many instances, or a lump sum may be paid per year for the service. In many towns the water used in this way is measured by a meter, and whether so measured or not it is quite a general practice to charge by the thousand gallons for the water used or estimated as used, the price ranging from about 5 to 50 cts., but generally being below 25 cts. per 1,000 gallons.

The amount of water discharged at each flushing and the frequency of discharge of course vary greatly with local conditions, and under this head no distinction was made in the compilation between automatic and manual flushing.

Where an opinion on the subject was expressed flushing was held to be satisfactory, as might be expected.

Four forms of flushing tanks are described and illustrated in the report, their names and the

addresses of their manufacturers being as follows: The Adams Patent Automatic Flushing Siphon, Adams & Co., 10 Little Queen St., Westminster, London; Bodin's Patent Hydrostatic Flushing Siphon, W. H. Bodin & Co., Wednesbury; Doulton's Automatic Flushing Siphon, Doulton & Co., Lambeth, London; Field's Patent Automatic Siphon, Bowes, Scott & Western, Broadway Chambers, Westminster, S. W., London.

The Rogers Fields' flushing chamber in its latest improved form is clearly shown by the accompanying illustration. The siphon proper is of cast iron, and the trapping box is of wrought iron.

A CANAL FROM THE RED RIVER TO HUDSON'S Bay is proposed by Canadian promoters, and it is said that of 681½ miles, 616½ miles are already navigable for boats and have 7 ft. of water. The canal work will be in sections, the longest of which will be about two miles. Mr. Scoble, of Winnipeg, is said to be the engineer.

THE RACING YACHT "METEOR," now being built by Henderson & Co., of Glasgow, was designed by Mr. G. L. Watson, for the emperor of Germany. It is a keel boat, 128 ft. long over all, 89 ft. 5 ins. long on the water line, 16 ft. 6 ins. draft, and 25 ft. beam at the deck level. The lead keel is 50 ft. long on top, 25 ft. long on the bottom, 6 ft. 3 ins. deep at the front and 3 ft. 8 ins. deep at the rear, being of oval section, about 3 ft. 10 ins. thick at the widest part. The hull is of composite construction, with steel angles for ribs, English elm planking up to the water line and yellow pine planking above. The saloon is 25 ft. long, and there is accommodation for a crew of 40 men. The mast is a stick of Oregon pine 100 ft. long, with 86 ft. above deck, and the top mast is 50 ft. long, the total height from deck to truck being 100 ft. The greatest diameter of the mast is 32 ins. The boom is a steel tube, 110 ft. long, with inside bracing, and is 13 to 24 ins. in diameter. The bowsprit is 40 ft. long, with 15 ft. on the deck.

BOOK REVIEWS.

THE PLANNING AND CONSTRUCTION OF AMERICAN THEATRES.—By William H. Birkmire, author of "Architectural Iron and Steel," "Skeleton Construction in Buildings," etc. New York; John Wiley & Sons.; 8vo., 117 pp.; illustrated with many half-tone engravings and sections and plans.

The chief merit of this work lies in its excellent illustrations of the exterior and interior of the latest American theatres. The plans and cross-sections give a few general dimensions and the text supplements this information to some extent. So far as advice upon planning and construction goes, this is confined to some very general plans of balcony construction, with some very general remarks upon the acoustic precautions necessary, upon the best arrangement for properly viewing the stage and upon the stage and its appurtenances. The illustrations, however, are exceedingly numerous and well executed, and they are interesting as showing what handsome theatres our chief cities now possess, and are suggestive of ideas to the architect engaged in similar design. The text does not enter into the engineering features of construction or into the special details of theatrical construction further than we have already noted.

FIELD-BOOK FOR RAILROAD ENGINEERS.—Circular and parabolic curves, turnouts, vertical curves, leveling, computing earthwork, transition curves on new lines and applied to existing lines, together with tables of radii, ordinates, long chords, logarithms, logarithmic and natural sines, tangents, etc., and a metric curve table. By John B. Henck, A. M., late Professor of Civil Engineering in the Massachusetts Institute of Technology. Second revised edition. New York: D. Appleton & Co., 1896; 12mo.; 312 pp. $2.50.

Forty-two years have elapsed since the first edition of this pocket-book was issued, and the latest previous edition was published in 1881. In this last issue the compactness of form of the old edition is still retained, and room has been found for new matter by eliminating matter of little or no use in the field. The table of radii, ordinates and tangent deflections has been enlarged by giving the degree of curves for every two minutes up to 10°; for every four minutes up to 20°, and for every ten minutes thereafter. Some changes have been made in the other tables and a short metric curve table is added. The transition curve is more fully treated upon the basis of the cubic parabola, and for both simple and compound transition curves and their application to new and old work. The present edition has been practically rewritten, and the subject more fully treated and illustrated by new figures, which are removed from the appendix of the latest previous edition and put into their proper places. This is especially the case in the chapter on turnouts and crossings, and a number of new miscellaneous problems have been added. The chapter on transition curves referred to occupies about 20 pages, with its explanatory matter and the tables to be used in practice. The type now used is much clearer and somewhat larger than that hitherto employed, and it is safe to say that this new edition of a favorite old hand-book will be welcomed by railway engineers.

GENERAL SPECIFICATIONS FOR STEEL RAILROAD BRIDGES AND VIADUCTS.—New and Revised Edition, 1896, by Theodore Cooper, M. Am. Soc. C. E., Consulting Engineer, New York; Engineering News Publishing Co. 8vo.; pamph.; pp. 24. 25 cts.

Cooper's specifications have become such a standard authority that the appearance of a revised edition is a matter which will interest every engineer engaged in structural work. The last previous edition was published in 1890, and it is of much interest to compare the present edition with the one compiled six years ago and see in what manner the changes and progress of this period are shown in the specifications. Doubtless the most notable feature is the fact that these specifications call for steel only, whereas those of 1890 were for "Iron and Steel Railroad Bridges and Viaducts." This change is the more notable as Mr. Cooper, if we rightly recall, was among the conservative members of the profession who not so very long ago were still weighing the relative merits of iron and steel for structures of short span, in which the effect of shock is a considerable factor.

Comparing the loading, we find that the heaviest uniform load specified is the same as four years ago, 4,000 lbs. per lin. ft. The engine loading accompanying this, however, shows a considerable increase of weights on the wheels of tenders and engine trucks. For the lighter loadings a greater change is noted. The old Class B and Class C loadings are no longer given, and the lightest uniform load is 2,700 lbs. per lin. ft., whereas in the earlier specifications, 2,000 lbs. and 2,240 lbs. per lin. ft. were allowed in the lighter loadings.

In the types of bridges preferred for different lengths of span, we find the comparison as follows:

1890. Specifications.	1896.
Up to 16 ft..... rolled beams	Up to 20 ft.
16 to 70 ft..... riveted plate girders	20 to 75 ft.
70 to 100 ft..riveted plate or lattice girders..	75 to 120 ft.
Over 100 ft..... pin-connected trusses	Over 150 ft.
lattice or pin-connected trusses	120 to 150 ft.

Under floors, the allowable unit fiber strain on floor timbers of white oak or yellow pine is raised from 800 lbs. to 1,000 lbs. Unit strains for bridge members of various classes are entirely changed from what they were in the former specifications.

The minimum diameter of rollers under expansion ends of trusses is raised from 2 ins. to 2⅞ ins., and the pressure in pounds per lineal inch is not to exceed the product of the diameter of the roller in inches by 300. Thus a 4-in. roller is allowed a load of 1,200 lbs. per in. Under the old rule it was allowed a load of 1,000 lbs. It is also provided that for spans over 100 ft. the minimum roller diameter shall be 2⅞ ins. × 1 in. for each 100 ft. length of span over 100 ft. These rollers are also required to be turned from machinery steel.

We have noted, almost at random, the above changes; but these are only a few out of many, and in every paragraph it is evident that the author has carefully revised his work with a view to make it represent the latest and best practice. Our readers interested in bridge work will find it interesting and profitable, we are sure, to carry the comparison throughout the specifications and note what changes the last half dozen years have made.

THE ELEMENTARY PRINCIPLES OF MECHANICS.—Vol. III., Kinetics. By A. Jay Du Bois, C. E., Ph. D., Professor of Civil Engineering in the Sheffield Scientific School of Yale University. New York; John Wiley & Sons. Cloth; 8vo.; pp. 296; $3.50.

This volume is the third of a series, Vol. I. treating of Kinematics and Vol. II. of Statics. The frequent references throughout this volume to the earlier volumes indicate that it is designed to be used in connection with them. As a reference book for engineers, it would appear desirable to have the three books combined into one, but as stated in the preface they have been printed separately for the convenience of students. It is Prof. Dubois's idea, however, that his series of books shall not be considered merely as text-books for use during a college course, but that the students shall use them afterwards as reference books. He says:

Heretofore, works thus valuable for reference have been too condensed and too abstract. They are written for the engineer, not for the student. On the other hand, text-books for the student have been too elementary and too much abridged. They are intended for the beginner only and have no value for the progressive student. The present work is an attempt to take the beginner and leave him with a work which shall be of permanent value to him during and after his entire course.

The subject of applied mechanics is given in an engineering college course, if we can judge from the text books, apparently for two reasons—first, as a mental discipline, an exercise in mathematical gymnastics; and second, to give the student facility in the use of a mental tool, which he will need in his professional career as much as he needs arithmetic. There is such a thing as too much mathematics for an engineering student, not only occupying time which might be better devoted to the study of data and practice, but tending to over develop the mathematical faculty at the expense of the faculty of common sense. It seems to us that Prof. Dubois's work is open to this criticism. It bristles with calculus, which nine engineers out of ten forget within a few years after graduation, is full of the novel terms of which a few writers have made a "fad" for some years past, but which have not generally entered into engineering literature. We will give examples of some of these terms later. The definitions also do not seem to be as clear as they might be. For example, we quote the following from the first page of the book:

The science which treats of those measurable relations of matter, space and time involved in the study of the change of motion of bodies due to force is called Dynamics.

That portion of Dynamics which treats of those principles which are necessary for the discussion of forces and bodies in equilibrium, and generally of forces without reference to the change of motion caused by them we have called Statics.

That portion of Dynamics which treats of forces with reference to the change of motion caused by them we call Kinetics.

If we understand this, Dynamics relates to bodies whose motion is changing, and is divided into two parts: Kinetics, which is defined the same as dynamics, and Statics, which relates to bodies where motion is not changing, but which are at rest. If these definitions are any better or as good as the old-fashioned ones, which divided Mechanics into Kinematics, Dynamics and Statics, and never mentioned "Kinetics," we fail to see it. Rankine's definitions, we think, are good enough even for students of the present day. His definitions were as follows:

Kinematics.—The comparison of motions with each other, without reference to their causes, is a subject of a branch of geometry called Kinematics.

Statics and Dynamics.—Forces may take effect either by balancing other forces or by producing change of motion. The former of those effects is the subject of Statics; the latter that of Dynamics; these, together with Kinematics, already defined, form the three great divisions of pure, abstract or general mechanics.

We give now a few extracts showing the author's use of new and unfamiliar terms:

p. 2.—The unit of force is then that force which gives one unit of mass one unit of acceleration in the direction of the acceleration. This is called the poundal when the unit of acceleration is 1 ft.-per sec. per sec. and the unit of mass is the pound.

We like Weisfach's method better. He says, pp. 156, 157:

The most simple and therefore the most common way of measuring forces is by means of weight. . . . The measurement of weights or forces consists in comparing them to some given unchangeable weight which is assumed as the unit.

p. 3.—If we wish F in gravitation units, since one pound weighs g poundals, we have only to divide m by g.

Prof. Dubois seems to recognize the fact that the measurement of forces in "poundals" is apt to create confusion, for in numerous places throughout the book after stating the force in poundals he either translates it into pounds by dividing by 32.2 or else gives directions that it be so translated. It would have saved much space in the book and an immense amount of trouble to the student, who has to learn all about poundals in college and then forget them afterwards, if the word "poundal" had never been invented.

p. 31.—The unit of impulse is then the impulse of one unit of uniform force acting for one unit of time. The English absolute unit of impulse is therefore the poundal second. We may write it "pdl. sec."

p. 32.—The unit of momentum is then the momentum of one unit of mass moving with one unit of velocity. We may call a unit of velocity, or one unit of length per unit of time, a "velo." The English unit of momentum then is the pound-velo. (lb. velo.) The C. G. S. unit of momentum is then the gram. velo. (gr. velo.) or the kilogram-velo. (kil.-velo.) A committee of the British Association has proposed for this the name "bole."

We thought the name "bole" had "died a borning" and that it was buried in the reports of the British Association beyond hope of resurrection. We regret that Prof. Dubois has seen fit to bring it into the light of day again, and to give it a place alongside of the not much better terms "pdl. sec.," "lb.-velo.," and "kil.-velo."

p. 35.—The term "impulse" is unfortunately applied by some writers to a short lived force itself, instead of the term impulsive force as used above. This makes it necessary to speak of the "impulse of an impulse" when we wish to speak of impulse as used above. The term "impulsive force" has also been used to denote the impulse of a short lived force as used above, thus leaving no term to denote the short lived force itself.

Prof. Dubois not only gives his sanction to the introduction of new, and what seems to us worse than useless terms into the language of Mechanics, but he tries to get rid of some familiar and useful ones. Thus, on p. 16, he says, in regard to our old friend "centrifugal force:"

The term centrifugal force always signifies, then, the opposite aspect of the stress between the center and the body. In this sense it may properly be used, but as it is apt to be misleading it is just as well to discard it altogether.

Instead of "centrifugal force" he uses "deflecting force." We think it would have been better to follow Rankine who uses the terms deviating force and centrifugal force in ways which are generally understood, and not apt to be misleading, as follows:

Centrifugal force is the force with which a revolving body reacts on the body that guides it, and is equal and opposite to the deviating force with which the guiding body acts on the revolving body.

With the exceptions we have taken to Prof. Dubois's use of new terms and definitions, and to his methods which follow such use, his work is no doubt an excellent one. It is very full of practical examples, and the student who masters it will be well grounded in Mechanics, although we do not envy him the amount of labor that will be required to master it.